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TRUSTED SILICON STRATUS (TSS) WORKSHOP

NIMBIS SERVICES INCORPORATED

FEBRUARY 2011

FINAL TECHNICAL REPORT

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FOR THE DIRECTOR:

/s/

/s/

THOMAS RENZ
Work Unit Manager

EDWARD J. JONES, Deputy Chief
Advanced Computing Division
Information Directorate

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Marc Edwards

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Nimbis Services Incorporated
1616 Anderson Road
McLean VA 22102-1602

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14. ABSTRACT
Nimbis Services facilitated, organized and delivered a requirements workshop for the development of a private cloud computing infrastructure (Trusted Silicon Stratus or TSS) for trusted semiconductor design-to-release-manufacturing for the Department of Defense. The workshop was hosted at the IBM corporate offices in Bethesda, MD on September 9-10, 2010. Fifty-seven workshop attendees represented twenty six DOD organizations and private companies from across the Aerospace & Defense (A&D) industry. The workshop was successful in generating the interest, need, and requirements for the development of the TSS. During the Trusted Foundry Workshop in Burlington Vermont, sponsored by the NSA Trusted Access Program Office (TAPO), development of the TSS Demonstration Cloud received endorsement from TAPO.

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Cloud Based Design, Trusted Supply Chain, Trusted Electronics Design, Software as a Service, Electronics Design Automation, Information as a Service, Anti Tamper for Electronics, Counterfeit Resistant Electronics

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 PREFACE

Even for the most seasoned commercial semiconductor companies, establishing a new semiconductor design paradigm is a challenging undertaking. Application of a relatively new Information Technology (IT) enterprise architecture, **cloud computing**, to a semiconductor foundry signoff work flow adds a further degree of complexity to the effort. In order to assimilate positive mindshare for the Trusted Silicon Stratus (TSS) computing cloud (TSS Cloud), it was an important step to: (1) educate the target community, (2) address misinformation, and (3) establish an open dialogue on interests and requirements for the application of a multi-tenancy cloud computing architecture to semiconductor design.

The TSS Workshop served as a perfect vehicle for accomplishing the aforementioned goals. It is a credit to the Air Force Research Laboratory (AFRL) executive management who recognized that investing in the TSS Workshop could be the catalyst for building a groundswell of support and positive mindshare across the Department of Defense (DOD), Department of Energy (DOE), and the National Security Agency (NSA) to endorse the need to develop the Trusted Silicon Stratus Cloud. The AFRL's anticipated expectation was that by empowering Nimbis Services to bring together a core group of DOD semiconductor design organizations, along with the National Security Agency's Trusted Access Program Office (TAPO) program management, that an appropriate DOD funding agency would be compelled to champion a formal funding initiative for the TSS Cloud. In this sense, with the endorsement of the TSS Cloud architecture by TAPO program management during the TSS Workshop Summary Briefing at the Trusted Foundry Workshop in Burlington, Vermont on September 22nd, 2010, the AFRL's TSS Workshop objective was achieved.

2 ACKNOWLEDGEMENT

Nimbis Services would like to thank the Air Force Research Laboratory Information Directorate Chief Scientist, Dr. Richard Linderman, for his executive management support by funding the Trusted Silicon Stratus (TSS) Workshop.

In addition, Nimbis Services would like to provide a special acknowledgment for technical, logistical, and program support provided for the TSS Workshop by Program Manager, Dr. Thomas, Renz and Principal Engineer, Mr. John Rooks who provided invaluable technical guidance and direction for the TSS Workshop agenda. Active participation by Mr. Rooks and Dr. Renz during the TSS Workshop provided key AFRL support among the DOD community. Gracious thanks to Mr. Christopher Flynn and Mr. John McCanney for their thorough, expeditious, and efficient, contract support to Nimbis Services executive management. Finally, much gratitude is extended to David French, IBM Microelectronics, for generously offering the use of the IBM Federal Services offices located in Bethesda, MD for hosting the TSS Workshop.

Nimbis Services also acknowledges the proactive TSS Cloud support from Sandia National Laboratories MESA MicroFabrication & Microsystems Science, Technology & Components organizations. Gilbert Herrera, Director, Microsystems Science, Technology, & Components, provided a signed TSS endorsement letter, and Dr. Thomas Zipperian, Unit Director, MESA MicroFabrication, has provided managerial support throughout the initial TSS architectural phases. Tom Trodden, Rita Gonzales, and Richard Dondero have provided weekly logistical and program support for the TSS computing cloud.

Thanks also to Mike Wood and Joseph Neff, Space and Naval Warfare Systems Command (SPAWAR)-Pacific for their endorsement of the TSS cloud. Both Mike and Joseph have provided important support, guidance and input on the TSS use model and architecture. Nimbis Services thanks SPAWAR-Pacific for becoming a TSS Demonstration Cloud “Early Adopter”.

Special thanks to all of the TSS Workshop presenters and panelists from Cadence Design Systems, Synopsys, Magma Design Automation, Silvaco, UCLA, QuantAA, Sandia National Labs, IBM Microelectronics, IBM Software Group, Intel Software Group, and Cisco Systems.

3 PROJECT SUMMARY

This is the final report by Nimbis Services for AFRL Contract No. FA8750-10-C0202. A summary of work progress by this project includes the following:

- TSS Workshop was held on September 9th and 10th at the IBM corporate offices in Bethesda, MD.
- Identification of five (5) TSS Demonstration Cloud (TSS-DC) prototype "Early Adopters" ("DC5"): AFRL, SPAWAR, Sandia National Labs, Boeing, IBM Microelectronics.
- TSS Summary Briefing completed at the Trusted Foundry Workshop IBM plant location in Burlington, Vermont.
- TSS architectural endorsement by NSA TAPO program management.
- Commitment from IBM Microelectronics to allow Nimbis Services to port the IBM Design Cloud to the initial deployment of the TSS Cloud.
- Cooperative collaboration for TSS cloud security architecture from IBM Software Group, Cisco Systems, and Intel Software Group.

As outlined in Figure 1, three (3) primary themes, namely, (1) security, (2) cloud computing architecture, and (3) semiconductor design flow were the focus of the TSS Workshop. The TSS Workshop agenda was tailored to address these workshop themes with domain expertise support for presenters of the agenda topics.

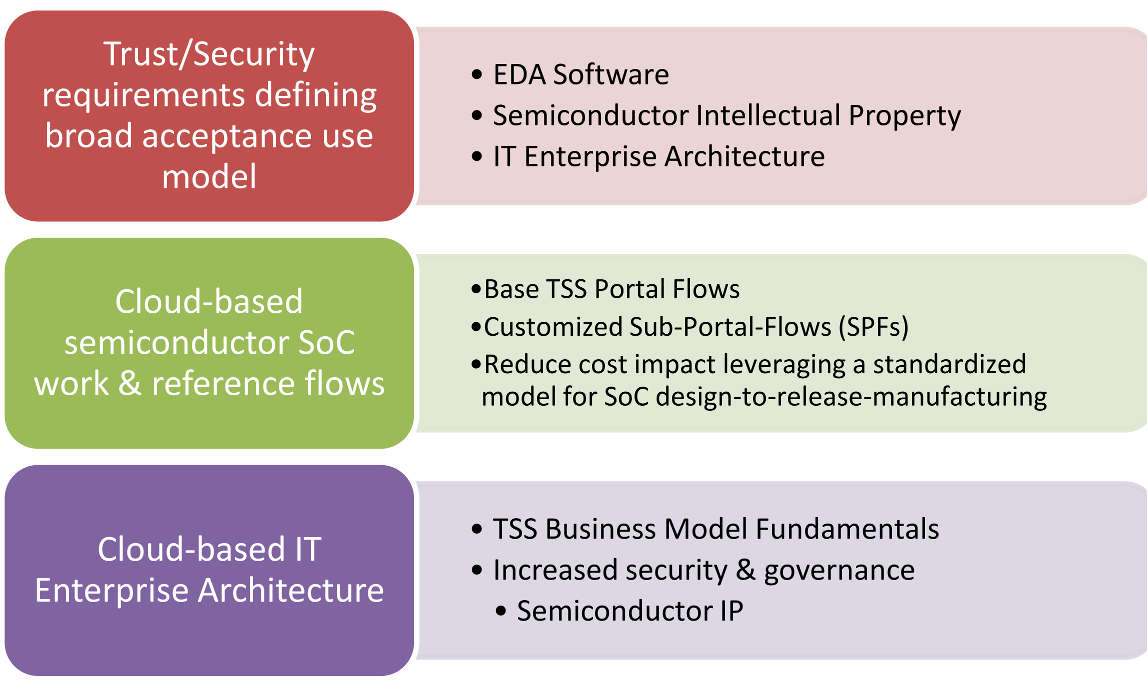

Figure 1 - TSS Workshop Three (3) Primary Themes

4 INTRODUCTION

At the same time when United States competitiveness in manufacturing is being challenged by low cost labor markets around the world, the application of high performance computing to industrial design and processes holds the best promise for restoring technological advantages that the United States has enjoyed for much of the 20th century. No manufacturing problem in industry today is more acutely affected by external market forces than the semiconductor industry. The Department of Defense's (DOD) market leverage in the semiconductor market has shrunk to ~1% of the total semiconductor market, while semiconductor design costs have continued to push small to medium sized semiconductor design companies out of the semiconductor design business.

While the Department of Defense is not a for-profit ongoing concern, the price of delivering state-of-the-art communications, weapons and reconnaissance platforms factor heavily into budget appropriations. At the present level of and inflationary target costs for semiconductor design, the financial realities and practical aspect of the DOD continuing to design semiconductor components will come under intense scrutiny. As a result, semiconductor design teams across the DOD are seeking ways to reduce design costs as well as project development schedules. The upfront costs of software and IT infrastructure have become prohibitive to manage across separate and disparate semiconductor design shops across the DOD.

The application of cloud computing provides an immediate relief to government design engineers that are struggling with reduced budgets and increasing demands to respond quicker to defense threats to crises. In 2008, "The 10 laws of Cloudonomics" (Weinman, 2008) provided a succinct set of ten (10) thematic elements that provided the foundation upon which an analysis could be applied to any increasingly complicated, high cost Information Technology problem. Figure 2 and Figure 3 outline these ten laws of "cloudonomics". The Trusted Silicon Stratus (TSS) represents an IT application of these ten cloudonomics laws that will reduce costs and project schedules for semiconductor component design. The TSS Workshop provided a basis upon which to coalesce stakeholders and parties across the DOD to address the implementation of the TSS Cloud.

1. Utility services cost less even though they cost more.

- An on-demand service provider typically charges a utility premium—a higher cost-per-unit time for a resource than if it were owned, financed, or leased. However, although utilities cost more when they are used, they cost nothing when they are not. Consequently, customers save money by **replacing fixed infrastructure with clouds when workloads are spiky**, specifically when the peak-to-average ratio is greater than the utility premium.

2. On-demand trumps forecasting.

- The ability to provision capacity rapidly means that any **unexpected demand can be serviced, and the revenue associated with it captured.** The ability to rapidly de-provision capacity means that companies don't need to pay good money for nonproductive assets. Forecasting is often wrong, especially for black swans, so the **ability to react instantaneously means higher revenues and lower costs**.

3. The peak of the sum is never greater than the sum of the peaks.

- Enterprises deploy capacity to handle their peak demands: A tax firm worries about Apr. 15, a retailer about Black Friday, an online sports broadcaster about Super Sunday. Under this strategy, the total capacity deployed is the sum of these individual peaks. However, since clouds can reallocate resources across many enterprises with different peak periods, a cloud needs to deploy less capacity.

4. Aggregate demand is smoother than individual.

- **Aggregating demand from multiple customers tends to smooth out variation**. Specifically, the "coefficient of variation" of a sum of random variables is always less than or equal to that of any of the individual variables. Therefore, clouds get higher utilization, enabling better economics.

5. Average unit costs are reduced by distributing fixed costs over more units of output.

- While large enterprises benefit from economies of scale, larger **cloud service providers can benefit from even greater economies of scale, such as volume purchasing, network bandwidth, operations, administration, and maintenance tooling**.

Figure 2 - The 10 Laws of Cloudonomics - 1 to 5 (Weinman, 2008)

6. Superiority in numbers is the most important factor in the result of a combat (Clausewitz).

- The classic military strategist Carl von Clausewitz argued that, above all, numerical superiority was key to winning battles. In the cloud theater, battles are waged between botnets and DDoS defenses. A botnet of 100,000 servers, each with a megabit per second of uplink bandwidth, can launch 100 gigabits per second of attack bandwidth. An enterprise IT shop would be overwhelmed by such an attack, whereas a large cloud service provider—especially one that is also an integrated network service provider—has the scale to repel it.

7. Space-time is a continuum (Einstein/Minkowski).

- A real-time enterprise derives competitive advantage from responding to changing business conditions and opportunities faster than the competition. Often, decision-making depends on computing, e.g., business intelligence, risk analysis, portfolio optimization, and so forth. Assuming that the compute job is amenable to parallel processing, such computing tasks can often trade off space and time, for example **a batch job may run on one server for a thousand hours, or a thousand servers for one hour**, and a query on Google is fast because its processing is divided among numerous CPUs. Since an ideal **cloud provides effectively unbounded on-demand scalability, for the same cost, a business can accelerate its decision-making**.

8. Dispersion is the inverse square of latency.

- Reduced latency—the delay between making a request and getting a response—is increasingly essential to delivering a range of services, among them rich Internet applications, online gaming, remote virtualized desktops, and interactive collaboration such as video-conferencing. However, to cut latency in half requires not twice as many nodes, but *four* times. For example, growing from one service node to dozens can cut global latency (e.g., New York to Hong Kong) from 150 milliseconds to below 20. However, shaving the next 15 milliseconds requires a thousand more nodes. There is thus a natural sweet spot for dispersion aimed at latency reduction, that of a few dozen nodes—more than an enterprise would want to deploy, especially given the lower utilization described above.

9. Don't put all your eggs in one basket.

- The reliability of a system with n redundant components, each with reliability r, is 1-(1-r)n. So if the reliability of a single data center is 99%, two data centers provide four nines (99.99%) and three data centers provide six nines (99.9999%). While no finite quantity of data centers will ever provide 100% reliability, we can come very close to an extremely high reliability architecture with only a few data centers. If a cloud provider wants to provide high availability services globally for latency-sensitive applications, there must be a few data centers in each region.

10. An object at rest tends to stay at rest (Newton).

- A data center is a very, very large object. While theoretically, any company can site data centers in **globally optimal locations that are located on a core network backbone with cheap access to power, cooling, and acreage, few do**. Instead, they remain in locations for reasons such as where the company or an acquired unit was founded, or where they got a good deal on distressed but conditioned space. A cloud service provider can locate greenfield sites optimally.

Figure 3 – The 10 Laws of Cloudonomics - 6 to 10 (Weinman, 2008)

Nimbis Services is in the forefront of the application of cloud computing and utility computing business models to a variety of manufacturing and high performance computing problems that span a number of diverse industry sectors. The design of semiconductor components provides what could be credibly argued as an idealized application of a technology disruption (cloud computing) to a high performance computing problem. The appeal of a cloud computing model for a standardized semiconductor design flow for the Department of Defense builds upon the previous assertion in an even more acute fashion.

Applying cloud computing architectures to drive down IT costs across the DOD and the federal government has received extensive funding and deployment attention over the last two years. Vivek Kundra, the Federal Chief Information Officer, has provided status reports and progress updates on the effectiveness and benefits behind the government's adoption of cloud computing. Figure 4 provides a snapshot of information and facts on cloud computing initiatives within the Defense Information Systems Agency (DISA).

The results from the TSS Workshop that follow in this final report, the preceding factors, and the advancement in Web 3.0 Service Oriented Architectures (SOA) clearly show that the industry has reached a point of what has been referred to as a "perfect storm" for the development of the TSS computing cloud.

Figure 4 - Federal & DOD Cloud Computing Deployments

5 METHODS, ASSUMPTIONS, PROCEDURES

5.1 TSS Workshop Agenda

A critical part of assembling the TSS Workshop was to find the right balance for the size of the workshop attendance. It was recognized early that assembling hundreds of attendees would make it difficult to manage the logistics and also inhibit a core exchange of ideas and requirements for the DOD TSS user community. At the TSS Workshop kickoff meeting at the AFRL in Rome, NY it was agreed that attendance for the TSS Workshop would be: (1) limited to approximately 50 persons, (2) by invitation only, and (3) require US citizenship. A semiconductor design and IT use case online survey using the SurveyMonkey® website was created and disseminated to the DOD community which also served as a guiding factor in the workshop agenda. The SurveyMonkey results were reported to the Air Force and are available from Nimbis Systems Inc.

The primary challenge the Nimbis team needed to execute upon was identifying, contacting, scheduling, briefing, and confirming attendance to the 2-day TSS Workshop from across the DOD and associated federal agencies involved in semiconductor design. Web-based TSS briefings, conference calls, and attendance at the GOMAC Tech 10 conference provided the basis upon which a core group of TSS Workshop attendees was formed. The next challenge was filling out a comprehensive, diverse, credible, crisp, fast moving, engaging, and interesting agenda that would disseminate and receive the needed requirements for a TSS computing cloud. The final challenge involved managing the logistical aspects of registering, locating, scheduling the workshop at the IBM corporate offices in Bethesda, MD.

Nimbis Services set up an online TSS Workshop registration website to allow TSS Workshop attendees to formally register for the workshop and also provide a centralized location for presentation materials download and forum comments. Highlights include the diversified attendance of twenty-six organizations from across the Department of Defense, Department of Energy, the National Security Agency, the National Reconnaissance Office, private Aerospace and Defense (A&D) and non-A&D commercial companies. The agenda presenters, panelists, and participants were selected based upon domain expertise and technical relevance to the agenda topic. The 2-day agenda for the TSS Workshop is listed below in Table 1, 2 and Table 3 lists the attendees.

5.1.1 Thursday, September 9th, 2010

Table 1 - Thursday Agenda

8:00am - 8:45am	CONTINENTAL BREAKFAST	
9:00am - 9:15am	WELCOME & INTRODUCTORY COMMENTS: Workshop Chair	J. Marc Edwards, Nimbis Services
9:15am - 9:45am	PERSPECTIVE: Air Force Research Laboratory (AFRL)	John Rooks, AFRL, Rome, NY
9:45am - 10:15am	PERSPECTIVE: Sandia National Labs (SNL)	Rita Gonzales, SNL, Albuquerque, NM
10:15am - 10:45am	PERSPECTIVE: IBM EDA Methodology Flow & Leveraging Cloud Computing for SoC Design	Dr. Leon Stok, VP, EDA Technologies, IBM ST&G
10:45am - 11:00am	BREAK	
11:00am - 11:30am	KEYNOTE: Air Force Cloud Computing Demonstration Project	John Pritchard, IBM Software Group
11:30am - 12:00pm	KEYNOTE: Cloud Computing Security Architectures: Considerations in Cloud Security	Tan Thai, Senior Scientist, SNL Information Systems Analysis Center (ISAC)
12:00pm - 1:00pm	LUNCH	
1:00pm - 2:00pm	INTERACTIVE SESSION 1: Heterogeneous, XML-based SoC Reference Flow Methodology – “StratusFlow”	Paul Zuchowski (IBM EDA), Tim Brodnax (NMBS), Bob Schetlick (SNPS), Brad Tree (CDNS)
2:00pm - 2:30pm	INTERACTIVE SESSION 2: Web 2.0 SoC Design Portal Dashboard	Jack Erikson (CDNS), J. Marc Edwards (NMBS), Tim Brodnax (NMBS)
2:30pm - 3:30pm	INTERACTIVE SESSION 3: Trusted SoC Design Cloud IT Enterprise Architecture	J. Marc Edwards (NMBS), RJ Rao (IBM Research), Blake Dournaee (Intel), Dan Kent (Cisco)
3:30pm - 3:45pm	BREAK	
3:45pm - 4:45pm	INTERACTIVE SESSION 4: IaaS/SaaS “Cloud” Business Enterprise Architecture for Trusted SoC Design	Ruth Fisher (QuantAA), J. Marc Edwards (NMBS), Mark Williams (SNPS), Ray Ross (CDNS)
5:00pm - 6:00pm	EVENING SOCIAL	

5.1.2 Friday, September 10th, 2010

Table 2 - Friday Agenda

8:00am - 8:30am	CONTINENTAL BREAKFAST	
8:30am - 9:30am	PANEL SESSION 1: Multi-tenancy SoC Design Classes Use Cases	Rita Gonzales (SNL), Mark Maurer (Silvaco), TBN (CDNS), David French (IBM Microelectronics)
9:30am - 10:30am	PANEL SESSION 2: Semiconductor IP Provisioning	TBN (IBM Research), John Thibeault (TAPO), Kathy Gambino (CDNS), TBN (NMBS)
10:30am - 11:00am	BREAK	
11:00am - 12:00pm	TUTORIAL: Integrated Circuit & System Security Techniques For Trusted Design	Dr. Miodrag Potkonjak, UCLA, Department of Computer Science
12:00pm - 1:00pm	LUNCH	
1:00pm - 1:30pm	TRUSTED SILICON STRATUS (TSS) PROTOTYPE PLAN: Phase 1 TSS Prototype Implementation Proposal	Tim Brodnax, Nimbis Services
1:30pm - 2:00pm	SUMMARY PRESENTATION: Report, Takeaways, Next Steps, Trusted Foundry Workshop Breakout Session	J. Marc Edwards, Nimbis Services

5.2 TSS Workshop Attendees

Table 3 - TSS Workshop Attendees

Attendee Name	Company/Organization	Number of Attendees	Group
David Rea	BAE Systems	1	A
Kathy Gambino	Cadence Design Systems	1	A
Jack Erikson	Cadence Design Systems	1	A
Ray Ross	Cadence Design Systems	1	A
Brad Tree	Cadence Design Systems	1	A
Brad Bryant	L3 Communications	1	A
Dan Both	NSA TAPO	1	C
Leon Stok	IBM EDA	1	A
Carl Anderson	IBM EDA	1	A
John Evans	Boeing	1	A
Lewis Cohn	National Reconnaissance Office (NRO)	1	A
John Rooks	Air Force Research Laboratory (AFRL)	1	A
Bob Gleichauf	In-Q-Tel	1	A
Dan Kent	Cisco Systems	1	A
Edwin Elmore	Cisco Systems	1	A
Chris Coleman	Cisco Systems	1	A
Sean Johnson	NSA TAPO	1	A
Mark Maurer	Silvaco	1	B
Bruce Jewett	Synopsys	1	B
Bob Schetlick	Synopsys	1	B
Mark Williams	Synopsys	1	B
Mike Wood	SPAWAR San Diego	1	B
Romeo Del Rosario	Army Research Laboratory (ARL)	1	B
Matthew Sale	NSWC Crane	1	B

Table 3 Workshop Attendees Cont.

Attendee Name	Company/Organization	Number of Attendees	Group
Saverio Fazzari	DARPA MTO - Trust in Integrated Circuits	1	B
Mark Whiting	Rockwell Collins	1	B
Tom O'Hern	ICFI	1	B
Greg Hudson	Intel	1	B
Allen Shortnacy	Intel	1	B
Blake Dournaee	Intel	1	B
Brian Cohen	IDA	1	B
Rich Dondero	Sandia National Laboratories	1	B
LeAnn Miller	Sandia National Laboratories	1	B
Rita Gonzales	Sandia National Laboratories	1	C
Paul Zuchowski	IBM EDA	1	C
James Doty	NSWC Crane	1	C
Joe Cole	Magma Design Automation	1	C
Kevin McDonald	ICFI	1	C
Jim Will	Kansas City Plant (KCP)	1	C
Tan Thai	Sandia National Laboratories	1	C
Nish Limaye	Rockwell Collins	1	C
Joseph Neff	SPAWAR San Diego	1	C
James Smith	In-Q-Tel	1	C
John Pritchard	IBM CCD	1	C
Miodrag Potkonjak	UCLA	1	C
JR Rao	IBM CCD	1	C
Dimitrios Pendarakis	IBM CCD	1	C
Tom Renz	Air Force Research Laboratory (AFRL)	1	C
James Wilson	Army Research Laboratory (ARL)	1	C

Table 3 Workshop Attendees Cont.

Attendee Name	Company/Organization	Number of Attendees	Group
David French	IBM Microelectronics	1	C
	QuantAA (Ruth Fisher)	1	
	Nimbis Services	5	
	Total Attendees	56	

6 RESULTS, DISCUSSION

6.1 Workshop Session Summaries

The following summary figures outline TSS issues, requirements, use cases, and panel discussions from the TSS Workshop agenda. Each figure consolidates the key points from the workshop keynotes and interactive sessions. The AFRL perspective session presented a typical use case and issues that semiconductor component designers in the AFRL would like to have addressed by the workshop and any resulting design service. Figure 5 lists inputs from several AFRL research groups using EDA design. General areas of concern included simplified administration of design tools and IP, trusted data and information management and creation of a trusted knowledge base for technology transfer of research results to other users. Other issues found in an AFRL wide survey were reported including long term support for older technologies and legacy systems, buy in from big/critical users such as high dollar platform avionics and nuclear control systems and support for mixed technology design and fabrication.

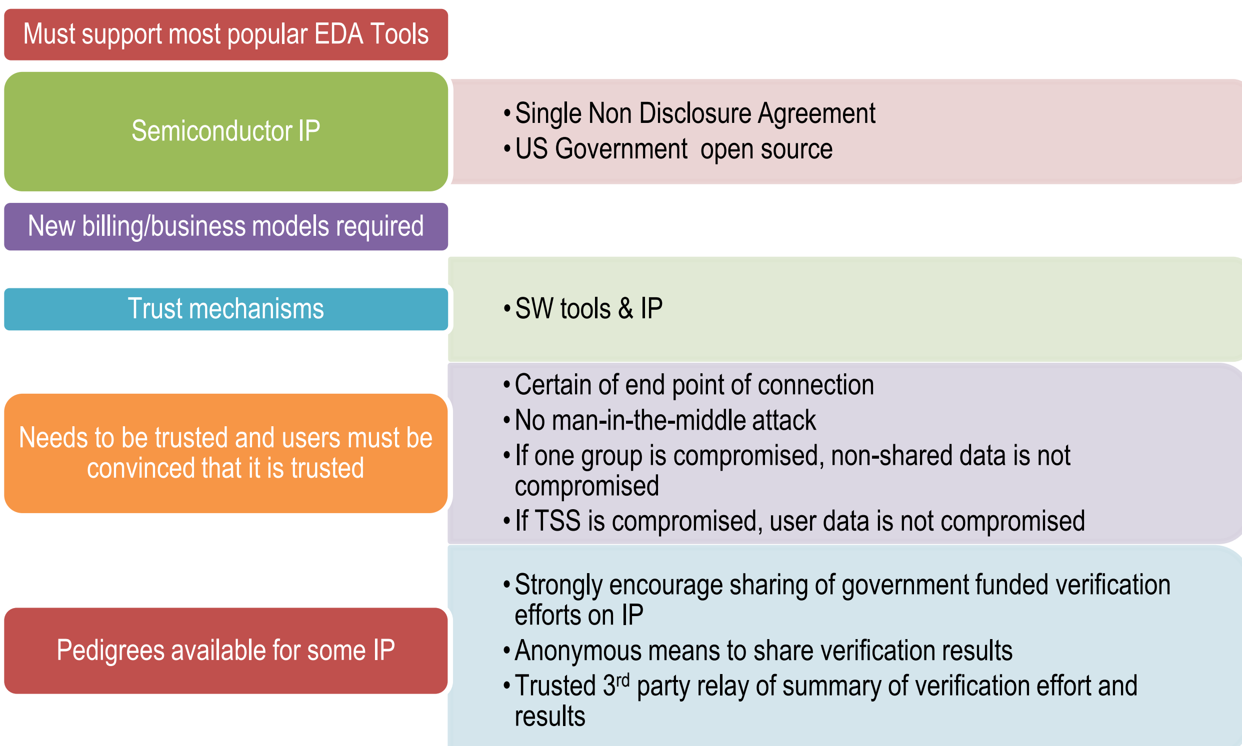

Figure 5 - TSS Workshop (AFRL Takeaways)

The second perspective session was presented by Sandia National Laboratories. Researchers from Sandia described semiconductor design processes they presently use and changes they would like to see. A list of the trusted design cloud features desired by researchers from Sandia is given in Figure 6 and Figure 7. The issue of affordability and a business model that makes the financial case for a cloud service was discussed. A presentation of security concerns for semiconductor system design at Sandia National Laboratories was given next. Trust and security are a major issue for Sandia. Issues identified included network security, internal cloud security, and security and trust of applications such as the design tools and outside IP used for design. Figure 6 lists some of the security and trust features Sandia would expect to see in a cloud design service.

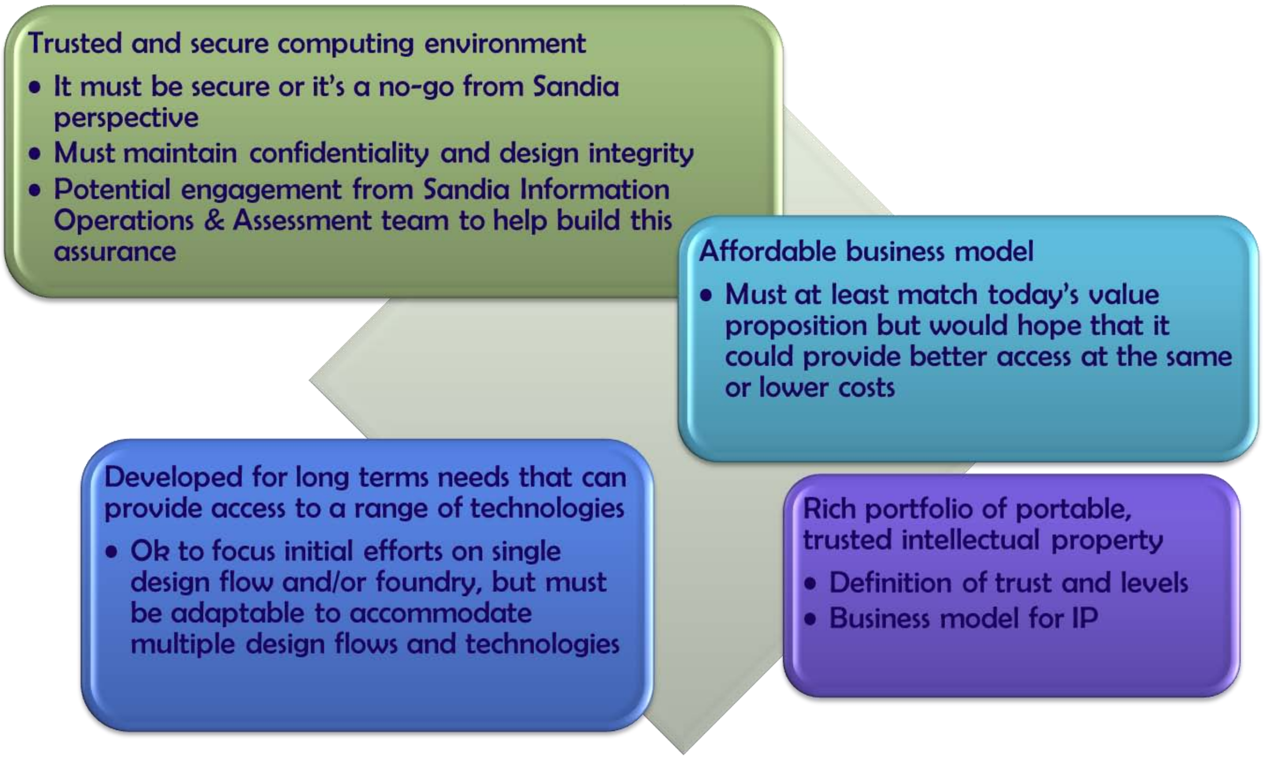

Figure 6 - TSS Workshop (Sandia Takeaways)

Figure 7 - TSS Workshop (Sandia Takeaways 2)

The IBM Design Cloud service was described in the third perspective session. This service is used by over 3,000 corporate designers around the world utilizing a computing cloud of 20,000 processing cores to create semiconductor component designs for IBM. Compelling statistics were given to show that a well-managed cloud based design service can significantly reduce cost while actually reducing the time to complete a design. Figure 8 describes features of the IBM Design Cloud and its business case.

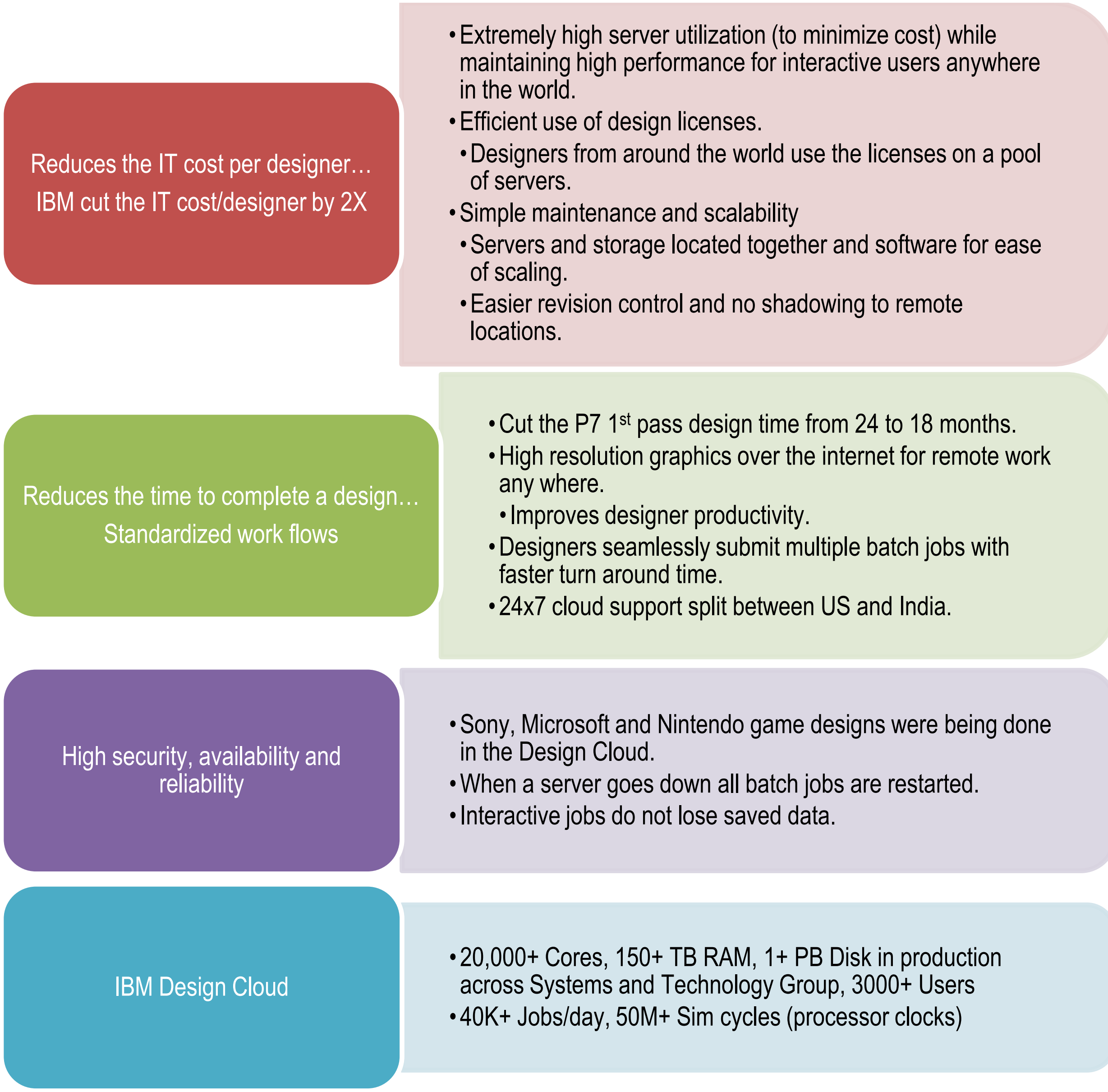

Figure 8 - IBM Microelectronics Keynote

A presentation was given by an IBM researcher on an Air Force project to create a multi-tenancy cloud computing environment. Scheduling and workflow were described. Issues for provisioning and monitoring and metering of the cloud were described. Network design was identified as a critical issue for success.

The first interactive session centered on the creation of a reference flow environment. The session panel consisted of representatives from major design tool providers: Cadence, Synopsys and IBM EDA. The session focused more on identifying a tool provider based consensus list of issues that need to be addressed by the reference flow than on proposing solutions. Figure 9 lists issues identified.

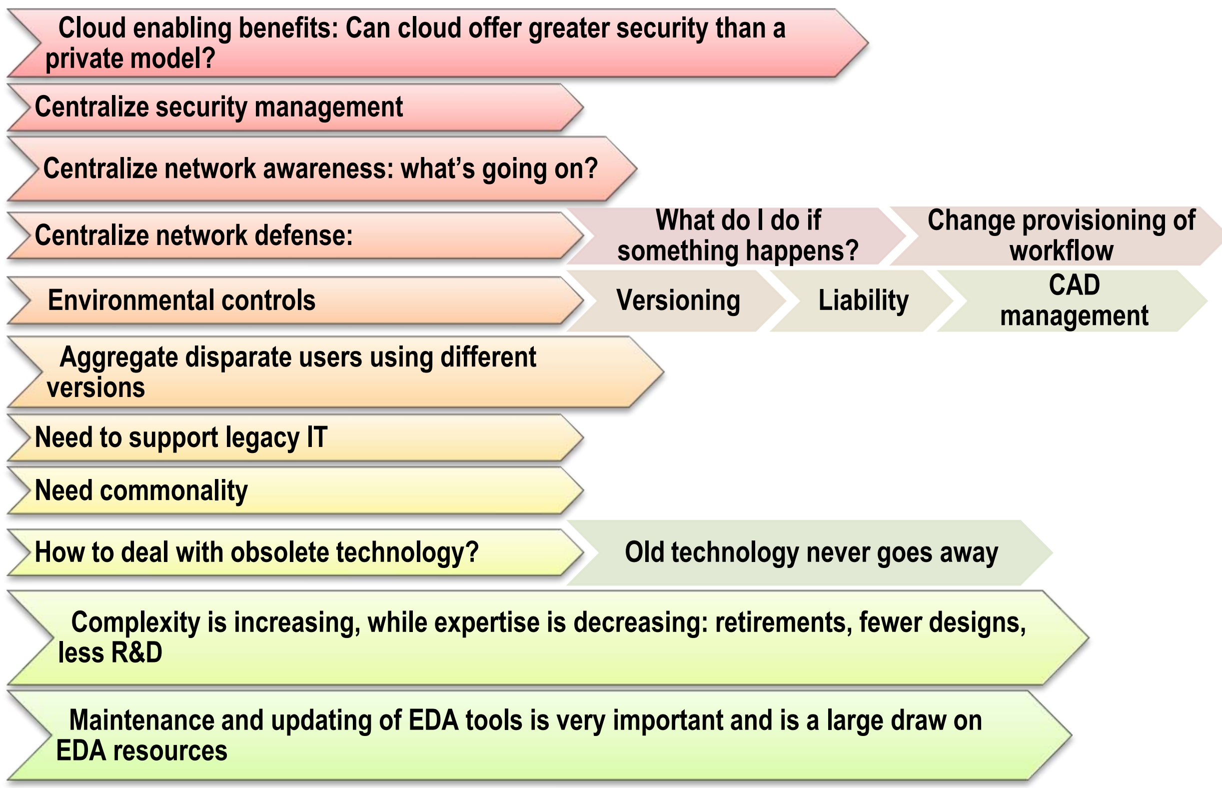

Figure 9 - Interactive Session 1 - SoC Design Flow

Interactive Session 2 addressed the requirements for a design portal interface. Cloud architecture requirements for supporting the different types of expected users were identified. Other architecture issues and requirements were discussed in Interactive Session 3 along with some straw man architectures presented by panel members from commercial providers of cloud systems. As with all sessions, achievement of security and trust was discussed. Figure 10 lists the requirements and characteristics identified for the user interface in Session 2 and the cloud architecture in Session 3.

IS2 Dashboarding

- ChipEstimate (Cadence)
- Lynx (Synopsys)
- Magma, Talus FlowManager

Important takeaways

- User Interfaces
  - Intuitive
  - Customized
  - Flexible → tool & IP

IS3 Cloud Computing

- Cisco Systems
- Unified Computing System
- IBM
  - Cloud Reference Model
- Intel
  - Security Gateway Appliance

Important takeaways

- Integrated
  1) Processor
  2) Storage
  3) Network
  Cloud computing architecture
- Specific Research in cloud data security, new for this app (DRaaS)
  Specific DoD secure clouds
- Security specific middleware appliance
  1) Platform agnostic
  2) Widely deployable

Figure 10 - Interactive Session 2 & 3 - Dashboarding & Cloud Computing

The final interactive session dealt with the business case for a proposed Infrastructure-as-a-Service (IaaS)/Software-as-a-Service (SaaS) cloud architecture. User desires for innovative pricing and billing were discussed. The cost model for a notional cloud was discussed and feature costs were proposed. Those were compared to costs for similar capabilities in the current model. The comparison would make the business case for the cloud based system. Issues identified included the savings from more efficient utilization of resources due to economies of scale and reduction of down time, novel pricing schemes such as paying only for successful incorporation of Semiconductor Intellectual Property (SIP), after the design is complete, and savings from the DOD and other government agencies not paying for the same license multiple times. Figure 11 provides a list of issues identified. Of interest was how to make the new pricing schemes win-win for the users and the design tool vendors. Possibilities included the idea of charging a low entry fee and then mortgaging any successful design for a higher fee than is currently charged. This would reduce the cost of exploration which would increase the customer base for the tool vendors. A successful design would be worth the higher back end cost of the license. The need for an independent assessment of the business case for any future proposed cloud service was identified as essential to help funders justify the cost.

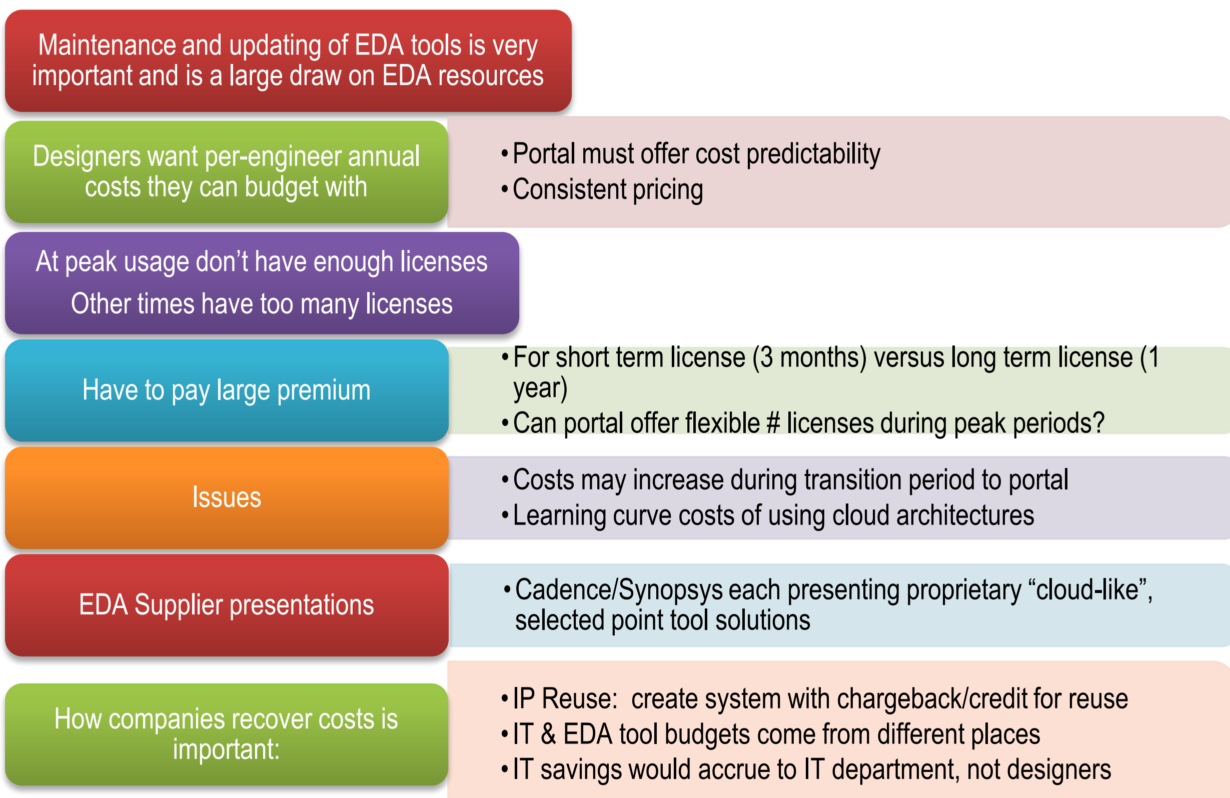

Figure 11 - Interactive Session 4 - TSS Business Model Discussion

The second day panel sessions covered two topics concerning services provided by the cloud. The Multi-Tenancy Panel addressed the scope of the design environment and the Semiconductor Intellectual Property (SIP) Provisioning Panel addressed SIP issues in the design process. There was significant concern about the scope that the design service would need to cover multiple users' needs for tool flow. Potential users exist for every CMOS technology generation as well as mixes with other technology classes such as analog mixed signal, Micro Electrical Mechanical Systems, and 3D combinations. The business case requires the design cloud to reach sufficient users. The high cost of licenses argues for fewer classes. A balance will be needed to provide a service that addresses a critical mass of DOD users.

Two themes that came up in the SIP panel discussions were sharing of SIP, making access open and convenient for authorized users, and the security of SIP, making authenticated SIP secure from unauthorized users. Concerns identified in the panel discussion are listed in Figure 12. Possible solutions discussed included the use of authentication technologies such as Physically Unclonable Functions (PUF) and a knowledge base with previous DOD user supplied metadata attached to the SIP, made possible by the existence of the cloud for administration. Digital Rights Management (DRM) could also be performed in the administration function of the cloud.

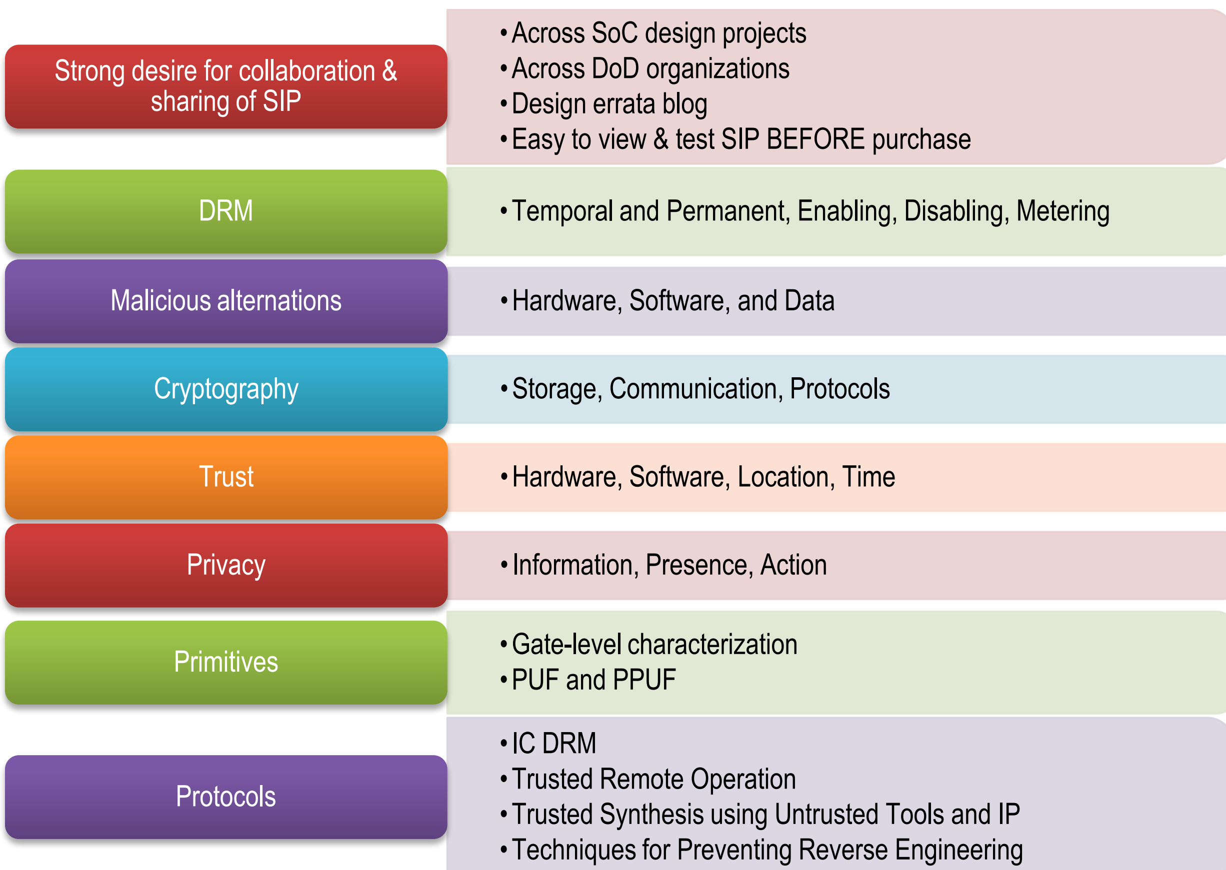

Figure 12 - Semiconductor IP Provisioning Panel & Takeaways

Following the panel sessions, a tutorial was given by Professor Potkonjak of UCLA on new techniques to achieve trusted design. Included were new hardware techniques to prevent system takeover and hardware to verify hardware authenticity such as Physically Unclonable Functions and Public Physically Unclonable Functions (PPUF).

The workshop was concluded with a description of a prototype design service proposed by Nimbis Services for implementation in the near future. Plans for completion of the prototype service were discussed along with features and teaming.

7 CONCLUSIONS

Figure 13 provides a sampling of positive comments from workshop attendees.

"…best run government workshop that I have been to. Everyone attending was engaged in what was being presented."

"Very informative. This was information that needed to be discussed at this time."

"Well worth the time and travel. Not disappointed."

"Surprised at the number of people that stuck around for the 2nd day."

Figure 13 - TSS Workshop Quotes from Attendees

7.1 TSS Workshop Completed

From the TSS workshop emerged seven (7) very strong TSS cloud foundational supporters and early adopters:

1. Air Force Research Laboratory (AFRL)
2. Sandia National Laboratories (SNL)
3. Navy SPAWAR
4. Boeing Corporation
5. IBM ➔ (1) Software Group & (2) Microelectronics
6. Cisco Systems

All of the TSS Workshop presentation materials have been uploaded to the Nimbis Services TSS Workshop website. Access to the materials, for Government only, has been made available through Nimbis Systems Inc.

The workshop proved to be an opportunity to consolidate key opinions and defined the need for the TSS cloud for semiconductor design across the Aerospace & Defense industry. It was extremely important for the NSA TAPO executive personnel and program management to be in attendance at the workshop. This provided a clear picture of the need to further explore the opportunity for enhanced productivity, reduced schedules, and paradigm shift in semiconductor design that the TSS cloud could provide.

7.2 TSS Workshop Results

The TSS Workshop provided a venue that allowed the present state of the DOD semiconductor design business to be documented and reviewed. The demand for a consolidated solution for semiconductor design across the DOD is high. The time is also right for the DOD to take the same steps that commercial semiconductor design companies have taken in consolidating and standardizing semiconductor design flows. The TSS Workshop has reinforced the DOD's organizational nature in that the DOD is a much larger entity than any single private semiconductor company. The DOD has a need for distinct compartmentalization and yet must also leverage the cost advantages of economies of scale and productivity efficiencies that come with standardized processes and collaboration. The TSS Cloud provides an enterprise architecture that can meet the diverse, yet collaborative constraints of DOD semiconductor design.

The TSS Workshop identified a core group of TSS Cloud “early adopters” from which the initial enterprise architecture can be tested and evolve based upon the use case models represented by these core early adopters. In Sandia National Laboratories case, the SNL semiconductor design team appropriately tapped Sandia’s Information Systems Analysis Center (ISAC) to determine if a secure cloud technology for semiconductor design could be developed. The positive affirmation from Sandia ISAC provided the basis upon which Sandia National Labs Microsystems organization could move forward in cooperating with the DOD in championing the TSS Cloud as a solution to meet their future needs.

The TSS Workshop attendees represented all four (4) TSS identity profiles, namely, (1) Designer, (2) Foundry, (3) EDA Supplier, and (4) IP Provider. One of the key issues coming into the TSS Workshop was whether the TSS Cloud could effectively create a collaborative ecosystem under which all four TSS identity profiles could effectively carry on profitable business operations. As evidenced from workshop contributions and participation from Cadence Design Systems, Synopsys, and Magma Design Automation, the workshop established a cooperative attitude under which the TSS Cloud could be developed and Nimbis Services would be able to provide a utility cloud offering the broadest spectrum of EDA tools, foundry services, and SIP. Figure 14 outlines an additional set of summary statements of consensus and issues that the TSS Workshop was able to identify and articulate for further discussion and research.

General Consensus

- TSS portal concept is addressing a problem in the A&D SoC design community that has been pervasive for MANY years.
- The present state of SoC design is driving the urgency of a solution now.
- Present state of IT technology, semiconductor stakeholder business models and concerns have created a "perfect storm" for progress.
- Importance of collaborative design environment
- DoD design competiveness & viability necessitate addressing SoC design costs and manufacturing FROM the design-to-release-manufacturing phase
- Need more details on…
  - Proposed TSS architecture, early adopters

Issues

Security

➔ Non-uniform level of understanding of multi-tenancy/cloud IT security architectures

TSS Business model

➔ Current model is broken, change to leverage DoD economies of scale

- EDA companies workshop presence and feedback emphasizes a win-win scenarios...
- One EDA vendor…
  - "this A&D sector represents a niche segment that can effectively explore delivering a cloud-based model."
- Willingness to proceed in business discussions.

Figure 14 - TSS Workshop Summary Points

7.2.1 TSS Endorsement

A TSS Workshop Summary Briefing was presented at the Trusted Foundry Workshop in Burlington, Vermont on Wednesday, September 21st, 2010. Sandia Labs had reserved a separate breakout session in a conference room at the IBM site in Burlington, Vermont. Approximately twenty (20) persons attended the summary breakout representing, Synopsys, IBM Microelectronics, NSA TAPO, the Air Force Research Laboratory, Boeing Corporation, SPAWAR, Sandia National Laboratories, and the Semiconductor Research Corporation (SRC). NSA TAPO program management executives attended both the TSS Workshop as well as the TSS Workshop Summary Briefing at the Trusted Foundry Workshop at IBM in Burlington, Vermont.

An original AFRL/Nimbis goal for the TSS workshop was to explore and build the case for a TSS Cloud in cooperation with DOD Research & Engineering (DDR&E) and NSA TAPO, which manages the DOD's program access for leading edge semiconductor technology process nodes, primarily through the IBM Microelectronics trusted foundry. During the TSS Workshop Summary Briefing, the presentation of the TSS Workshop results and the input from the briefing attendees was compelling enough for NSA TAPO program management to acknowledge the TSS benefit and the need for further consideration and study. NSA TAPO program management also called for an additional TSS Cloud development study from the Institute for Defense Analyses (IDA) to work with Nimbis Services and the AFRL in defining the strategy and direction of the TSS Cloud.

7.2.2 Sandia National Laboratories (SNL)

SNL management and technical lead personnel contributed greatly to the convincing arguments for the development and need for the TSS cloud implementation. SNL had two senior directors, Tom Zipperian and Gil Herrera, who attended the TSS Workshop Summary Briefing. Both SNL directors offered frank and germane comments relative to the importance of the TSS strategy.

Additional research and investigation relative to the TSS production cloud implementation is being conducted by TAPO, the SRC, and Nimbis Services. A final note from the NSA TAPO program management has requested Nimbis Services to prepare a TSS IT cloud security briefing to the NSA that includes a comprehensive TSS cloud security architecture strategy.

7.2.3 IBM Microelectronics TSS Cloud Commitment

Discussions between Nimbis Services and IBM Microelectronics VP of EDA and Senior Technical Staff Member (STSM) personnel secured IBM's commitment to allow Nimbis Services access to IBM's internal Design Cloud semiconductor design reference flow. Nimbis Services will work with IBM Microelectronics to provision the IBM Design Cloud architecture as a serviceable, utility cloud computing service model for the TSS Cloud V1.0 as an EDA tool flow offering to both A&D and non-government SoC design teams. Augmenting the IBM Design Cloud as a base for the TSS Cloud architecture will provide a rapid production grade semiconductor design service for the DOD. As a first product offering through Nimbis Services, the TSS Cloud V1.0 will serve as the basis for enhanced SoC/Stratus Flow reference flows for subsequent generations of TSS Cloud releases.

7.3 Tasks 2 & 3 & TSS Production Prototype Next Steps

Nimbis Services and the AFRL are now in communication and contract review of the original Statement of Work (SOW) and deliverables for Tasks 2 & 3 in a follow on project. Various other sponsoring avenues for the TSS Prototype shown in Figure 15 are under review.

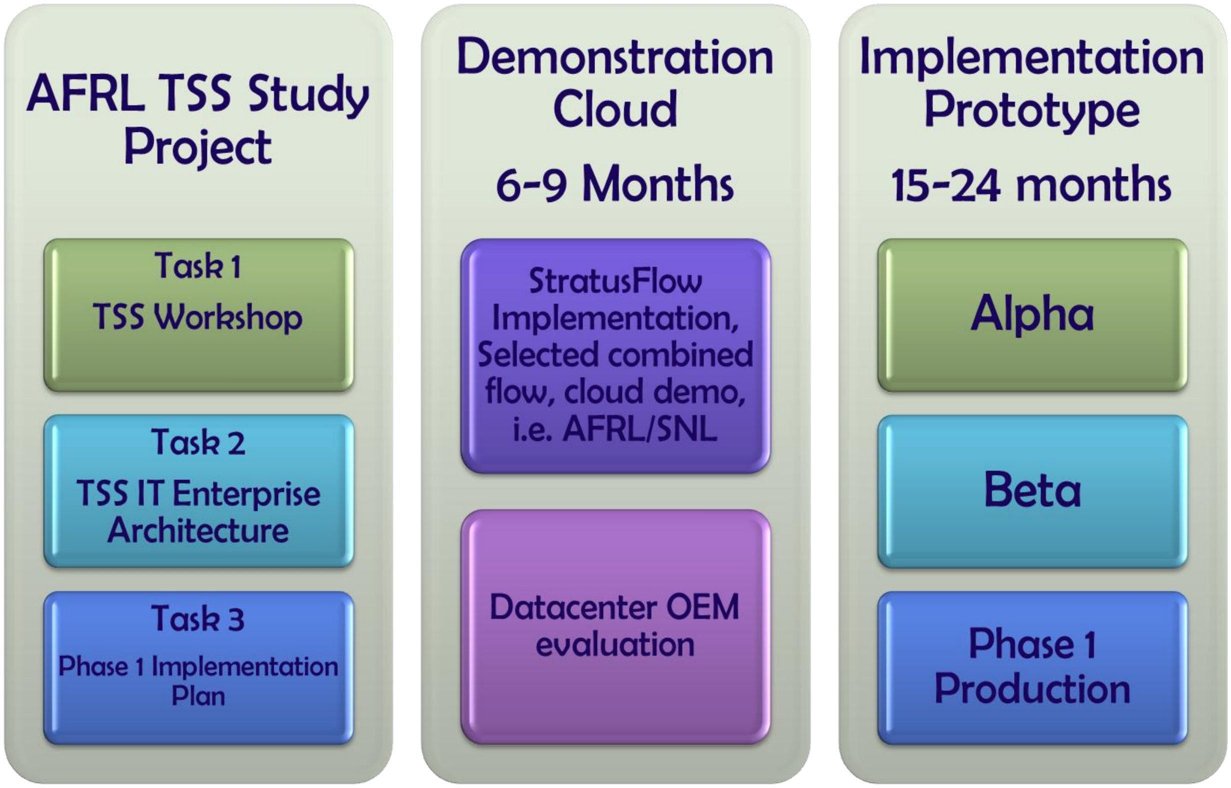

Figure 15 - TSS Prototype Proposal

8 ACRONYMS

A&D	Aerospace & Defense
AFRL	Air Force Research Laboratory
CAD	Computer Aided Design
CDNS	Cadence Tools
CMOS	Complementary Metal Oxide Semiconductor
DDR&E	Department of Defense Research & Engineering
DISA	Defense Information Systems Agency
DOD	Department of Defense
DOE	Department of Energy
DRM	Digital Rights Management
EDA	Electronic Design Automation
IDA	Institute for Defense Analyses
IaaS	Infrastructure-as-a-Service
IP	Intellectual Property
ISAC	Information Systems Analysis Center
IT	Information Technology
MEMS	Micro-Electro-Mechanical Systems
NDA	Non Disclosure Agreement
NMBS	Nimbis Services
NSA	National Security Agency
PPUF	Public Physically Unclonable Function
PUF	Physically Unclonable Function
SaaS	Software-as-a-Service
SIP	Semiconductor Intellectual Property
SNL	Sandia National Laboratories
SNPS	Synopsys Corporation
SOA	Service Oriented Architectures
SoC	System on a Chip
SPAWAR	Space and Naval Warfare Systems Command
SRC	Semiconductor Research Corporation
SW	Software
TAPO	Trusted Access Program Office
TSS	Trusted Silicon Stratus
TSS-DC	Trusted Silicon Stratus Demonstration Cloud
UCS	Unified Computing System
UCLA	University of California at Los Angeles
USG	United States Government

9 WORKS CITED

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