Breakout Area 3 - Federated Switched Optical Networking

Topic: Identify visions for what federated optical networking will be able to accomplish in 5-15 years, and applications that will be enabled, based on advances in the capabilities of this breakout area.

Findings:
Currently, there exists a potential for a substantial advances in communications technology based on next generation optical networking. For example, the applications that will be enabled will not simply be better versions of current applications , but applications that do not exist today. New macro architectural concepts will lead to advances in capacity, robustness, security, real time capabilities, and economic models . These concepts can be advanced by creating architecture and prototypes for what could be termed a “system-of-systems” or “meta systems” for next generation optical networks.

Recommendations:
A research program should be established that could address these issues. A wide ranging research program is required, which would address multiple key topics, within a macro context. This research program will require major nation and international facilities capable of supporting multiple large scale experimental network testbeds. Macro architecture investigation should encourage high risk, high potential interdisciplinary research areas.

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Topic: What basic research is needed to enable the next-generation of optical networks
operating at 100 Gbps and beyond?

Findings: Providing 100 Gbps and beyond will be important for many emerging and future applications. A basic research agenda for 100 Gbps and beyond cannot be developed in isolation from other major basic network research considerations. Such capabilities will
Influence many other communication areas. Therefore, a new general architectural frame work is required for all areas that would incorporate considerations of topics related to providing 100 Gbps and beyond. A detailed framework should not be a requisite for beginning to move toward a research agenda. A general framework should be sufficient. The research agenda will require addressing multiple interdisciplinary issues including those related to fiber design, optical switch architecture, design, and technology, optical signaling and transmission, and individual components. A systematic approach vs component approach is required, not merely transponder and asynchronous interfaces, but components within the context of larger systems.

Recommendations: A major new interdisciplinary basic research program is required to address these issues. Many current activities in these areas are not interdisciplinary, are oriented toward existing architecture and technologies, and are directed at

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Topic: What is the impact of ultra high-capacity optical networks (100 Gbps and beyond)
on current network technologies such as transport protocols (TCP/IP), host system stacks, routing algorithms, guaranteed QoS, cyber-security systems, and network devices (routers, switches, etc?

Findings: These research areas all underscore the need for a new general architectural frame work as a context for optical networking research. Consideration of capabilities for 100 Gbps and above challenge all of these traditional areas and require new techniques.

Recommendations: A basic research program should be designed that will allow for interdisciplinary conceptualization and experimentation among these areas, which have been traditionally separate. These areas of activity could be guided by a general architectural framework

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Topic: What systems-of-systems or meta-system development will be required to allow end-to-end applications to take advantage of terabit/sec network speeds?

Findings: Traditional approaches are highly centralized, are oriented toward single domain implementations, and are oriented toward legacy capabilities. Scalability requires a high degree of decentralization, inter-domain provisioning, and new capabilities. However, decentralization, interdomain provisioning, and the introduction of new capabilities give rise to multiple additional challenges. Currently, there are multiple suggested potential approaches to these issues. New basic research will be required to identify the best approaches. These approaches are not mutually exclusive. There are opportunities for determining the balance between central and decentralized approaches.

Recommendations: Within a general architectural framework, a research program should be developed that would allow for the design and development of a new systems of systems (meta system) architecture and prototype. In part, this research should focus on innovative management and control systems .

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Topic: What are the technical challenges of developing dynamically switched multi-domain optical networks in layers 1-3 including multi-domain issues such as control and signaling,
data plane peering/circuit exchange, E2E secure circuits, E2E circuit monitoring, E2E circuit protection and restoration, interplay of circuits and best-effort IP traffic, etc.

Findings: These issues also require the development of a generalize architectural framework. Requirement for point to point connection both complementary to Internet services as well as to alternatives to traditional IP routed networks. Current drivers include high end science. Architecture considerations that will drive the progress will include those related to admission control and costs . It is important to fundamentally reexamine if it is possible to continually overprovision as a common method to achieve capacity. E2E can employ capabilities for segmentation ,ultra high capacity and specialized admission control to enhance security. State information is important to these capabilities.

Recommendations: These topics are key areas for future research

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Topic: What type of research is needed to enable hybrid packet/circuit-switched optical networks including issues such as hybrid network traffic grooming, mix-traffic engineerir mix-technologies E2E paths, integration of IP-QoS, MPLS, and GMPLS?

Findings: For these concepts also , a comprehensive system of systems approach is r

Recommendations: These are key R&D topics.

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Topic: What is the impact of national and international standards on next-generation dynamically switched optical networks including standards such as ITU/ASON, IETF/GMPLS & MPLS, OIF, etc

Findings: The majority of standards organizations are oriented toward short term incre improvements of existing technologies. These organizations are also focused on narrowly defined areas.

Recommendations: New standardization processes, which can address more innovati longer term issues, should be developed to enable major advances in the design, development and adoption of new innovative capabilities.

Breakout Area 3 - Federated Switched Optical Networking

Topic: What are the potential payoffs of high-risk research such as:
All Optical Networks, optical GMPLS, Optical burst switching, network virtualization at the optical layer, optical wireless technologies (e.g., interfaces), etc?

Findings: All Optical Network remain a high risk potentially high reward research direction. Further investigation is required to evaluate the level of risk. Optical GMPLS
Has been shown to be low risk, currently it can be a useful tool. The potential of optical burst switching is another high risk potentially high reward area. Network virtualization at the optical layer is an essential objective. As both optical and wireless technologies evolve, it is important to consider the intersections of both.

Recommendations: Appropriate R&D topics are all Optical Network, optical GMPLS, optical burst switching (perhaps for delay intolerant applications) network virtualization at the optical layer, optical wireless technologies

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Topic: Is there a need for a national testbed optical testbed to prototypes advanced optical network technologies?

Findings: Such national and international testbeds are essential to advanced the required
research agendas described here. They should be designed and implemented so they can be highly segmented.

Recommendations: A large scale distributed facility is required within which communities of researchers can design, implement an operate different types of testbeds with different characteristics. This facility should be supported and made accessible to the research communities that require it.

Breakout Area 3 - Federated Switched Optical Networking

Topic: What are the challenges in federating optical networks?
Technical, policy, and programmatic issues of federated international optical networks.

Findings: Traditional provisioning is conducted within single domain. This area of resea
one that could be highly beneficial to new types of communication services

Recommendations: This is an important R&D area.

Breakout Area 3 - Federated Switched Optical Networking

Topic: What are the technical, policy, and programmatic issues of federated internationa optical networks?

Findings: Optimally designing and using new capabilities will require a basically new architectural context that must operate at a global scale. Currently Funding these efforts has been difficult

Recommendations: This is a key R&D area that will require international partnerships. This should be separately suporting

Breakout Area 3 - Federated Switched Optical Networking

Topic: To what degree should optical network R&D depend on application requirements
application drivers, Is this context a problem or an asset?

Findings: Such application contexts are useful, but should not be required.
There are various models for determining the raio of R&D with an application reference.

Suggested fsupport models include those that 1) supported app dev + 2) supported basic R&D

Recommendations:

Balance ratios between such activities pure R&D w/o ref to apps vary: e.g.,
70-30
20 80
50 50
60 40

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Topic: What are appropriate processes , organizational structures, support mechanisms, facilities etc for R&D in optical networking?

Findings: Traditional approaches are oriented to requirements that no longer exist. These traditional models should be reevaluated. New processes , organizational structures, support mechanisms, facilities for optical R&D are required.

Recommendations: There should be a more optimal balance between very large scale projects (e.g., Manhattan Project scale) and single investigator scale projects, as well as mid tier projects.

Breakout Area 3 - Federated Switched Optical Networking

Topic: What are the primary economic considerations ?

Findings: Various models exist, ranging from the macro scale (e.g., the requirements of
the national economy such as global concerns related to power) to micro scale (e.g ., low cost manufacturing leading to low cost commodity
optical components).

This topic directly relates to the system-of-systems considerations. Economic considerations
are an inherent part of the general architectural framework required for optical networking R&D.

Recommendations: A method for evaluating economic considerations, including risk reward frameworks, should be considered within the context of a general architectural framework.

Breakout Area 3 - Federated Switched Optical Networking

Topic: What are the appropriate technology transfer processes for advanced optical net
R&D?

Findings:
The demise of the major commercial communications R&D labs has diminished opportuni
for many types of R&D as well as for technology transfer.

Many current processes related to technology transfer and commercialization
are oriented to provider services. However, there are many
new constituencies for these technologies.

Recommendations: National policies should acknowledge the demise of the major
commercial R&D labs and the implications of their demise.
New processes should be established to ensure the replacement of the
required basic R&D processes that are no longer supported by commercial organizations.

Additional technology transfer processes should be implemented to address the requirem
non-traditional constituencies.

Breakout Area 3 - Federated Switched Optical Networking

Topic: What are the primary priorities related to ON R&D? How are these priorities determined?

Findings: Various options exist for R&D support --
Wavelength switching (e.g., cheaper ,smaller, better, faster…)
Architecture and protocols to maximize the use of phonic later adaptive topologies
Maximum use of capabilities, functions, components
Facilities capable of supporting many testbeds, many experiments, high density photonics
and electronics, P&E integration, optimized infrastructure,
wave length selective switches, new visions for architecture , multi granuality optical switch
Nodes, enhanced access capabilities, terabit LANs, phontonic RAM, optical packet switching
etc. No coherent mechanism exists for establishing priorities among the potential opportunities.

Recommendations: A process should be established to determine priorities among the options,
research opportunity areas, allowing for a wide range of experimentation and