

Feature	Characteristics that Motivate H-S Nets	Vision for the Future Process of Science	Anticipated Requirements	
Discipline			Networking	Middleware
Climate (near term)	<ul style="list-style-type: none"> • A few data repositories, many distributed computing sites •NCAR - 20 TBy •NERSC - 40 TBy •ORNL - 40 TBy 		<ul style="list-style-type: none"> • Authenticated data streams for easier site access 	<ul style="list-style-type: none"> • Server side data processing • Information servers
Climate (5 yr)	<ul style="list-style-type: none"> •Add many simulation elements/components as understanding increases •100 TBy / 100 yr generated simulation data – will run order 1000 such runs <ul style="list-style-type: none"> – Distribute to major users in large chunks – (list coming) – What is the nature of post simulation analysis, are the results data that are preserved? 	<ul style="list-style-type: none"> •Enable the analysis of model data by all of the collaborating community 	<ul style="list-style-type: none"> • Robust access to large quantities of data 	<ul style="list-style-type: none"> • Reliable data/file transfer <ul style="list-style-type: none"> –Across system / network failures –Re: data corruption
Climate (5+ yr)	<ul style="list-style-type: none"> •Add many diverse simulation elements/components, including from other disciplines - this must be done with distributed, multidisciplinary simulation • virtualized data to reduce storage load 	<ul style="list-style-type: none"> •Integrated climate simulation that includes all high-impact factors 	<ul style="list-style-type: none"> • Robust networks supporting distributed simulation - adequate bandwidth [estimate coming] and latency 	<ul style="list-style-type: none"> • Management of distributed, multidisciplinary simulations

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High Energy Physics (near term (1-2yr))	<ul style="list-style-type: none"> • Instrument based data sources • Hierarchical data repositories • Hundreds of analysis sites • Petabytes of data 	<ul style="list-style-type: none"> • Productivity aspects of rapid response 	<ul style="list-style-type: none"> • Gigabit/sec • end-to-end QoS 	<ul style="list-style-type: none"> • Secure access to world-wide resources • Data migration in response to usage patterns and network performance <ul style="list-style-type: none"> - Naming and location transparency • deadline scheduling for bulk transfers • policy based scheduling / brokering for the ensemble of resources needed for a task • Automated planning and prediction to minimized time to complete task
HEP (3-5 yr)	<ul style="list-style-type: none"> • 100s of petabytes of data • Global collaboration • Compute and storage requirements will be satisfied by optimal use of all available resources 	<ul style="list-style-type: none"> • Worldwide collaboration will cooperatively analyze data and contribute to a common knowledge base • discovery of published (structured) data and its provenance 	<ul style="list-style-type: none"> • 100 Gigabit/sec <ul style="list-style-type: none"> – lambda based point-to-point for single high b/w flows –Capacity planning • Network monitoring 	<ul style="list-style-type: none"> • Track world-wide resource usage patterns to maximize utilization • direct network access to data management systems • monitoring to enable optimized use of network, compute, and storage resources • publish / subscribe and global discovery
HEP (5-10 yr)	<ul style="list-style-type: none"> • 1000s of petabytes of data 		<ul style="list-style-type: none"> • 1000 Gigabit/sec 	

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Chem. Sci. (near term)	<ul style="list-style-type: none"> • High data-rate instruments • Greatly increased simulation resolution • Geographically separated resources (compute, visualization, storage, instruments) and people • Numerical fidelity and repeatability • Cataloguing of data from a large number of instruments 	<ul style="list-style-type: none"> • Remote visualization • Distributed collaboration • Remote instrument operation / steering (?) • 	<ul style="list-style-type: none"> • Robust connectivity • Reliable data transfer • High data-rate, reliable multicast • QoS 	<ul style="list-style-type: none"> • Collaboration infrastructure • Management of metadata • High data integrity • Global event services • Cross discipline repositories • Remote I/O • Network caching • Server side data processing • Virtual production to improve tracability of data • Data Grid broker / planner • Cataloguing as a service
Chem. Sci. (5 yr)				
Chem. Sci. (5+ yr)				

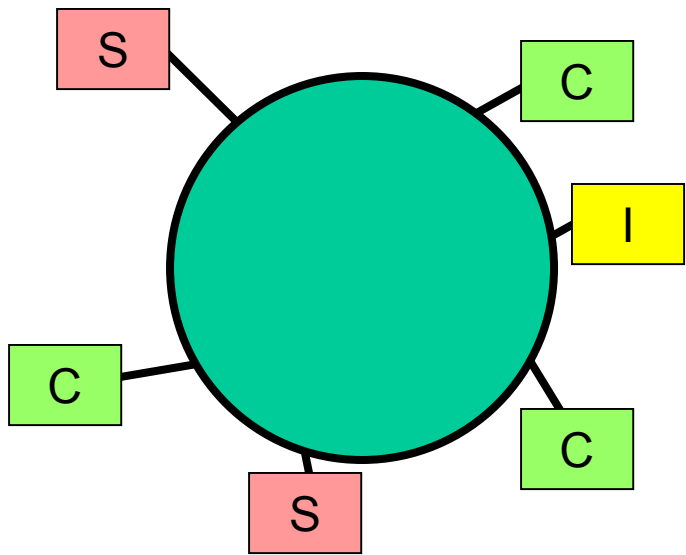
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Magnetic Fusion (near term)	<ul style="list-style-type: none"> • Each experiment only gets a few days per year - high productivity is critical • 100 MBy every 15 minutes to be delivered in two minutes • Highly collaborative environment 	<ul style="list-style-type: none"> • Real time data analysis for experiment steering (the more that you can analyze between shots the more effective you can make the next shot) 		
Fusion (5 yr)	<ul style="list-style-type: none"> • 1000 MBy - generated by experiment - every 15 minutes to be delivered in two minutes • 1000 MBy - generated by simulation - to be delivered in two minutes for comparison with experiment • Simulation data scattered across US • Transparent security • Global directory and naming services needed to anchor all of the distributed metadata • Support for “smooth” collaboration in a high stress environments 	<ul style="list-style-type: none"> • Real time data analysis for experiment steering combined with simulation interaction • Real time visualization and interaction among collaborators across US • Integrated simulation of the several distinct regions of the reactor will produce a much more realistic model 	<ul style="list-style-type: none"> • 500 Mbit/sec for 20 seconds out of 15 minutes, guaranteed • QoS • 5 to 10 remote sites involved for data analysis and visualization 	<ul style="list-style-type: none"> • Parallel network I/O between simulations, data archives, experiments, and visualization • High quality, 7x24 PKI infrastructure • end-to-end QoS • QoS management • Secure / authenticated transport to ease access through firewalls • Reliable data transfer • transient and transparent data replication for real-time reliability • Collaboration support
Fusion (5+ yr)		<ul style="list-style-type: none"> • Real time remote operation of the experiment 	<ul style="list-style-type: none"> • QoS for latency and reliability 	

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Bioinformatics (near term)	•	•		
Bio (5 yr)	<ul style="list-style-type: none"> •Service based usage •Electronic notebook •Workflow for automated annotation •Providence tracking across many changes of data 	•	•	<ul style="list-style-type: none"> •Transparent service location •Notebook servers (DAV, etc.) •Brokers / planners •Workflow engines •Open interchange standards for providence tracking
Bio (5+ yr)		•		

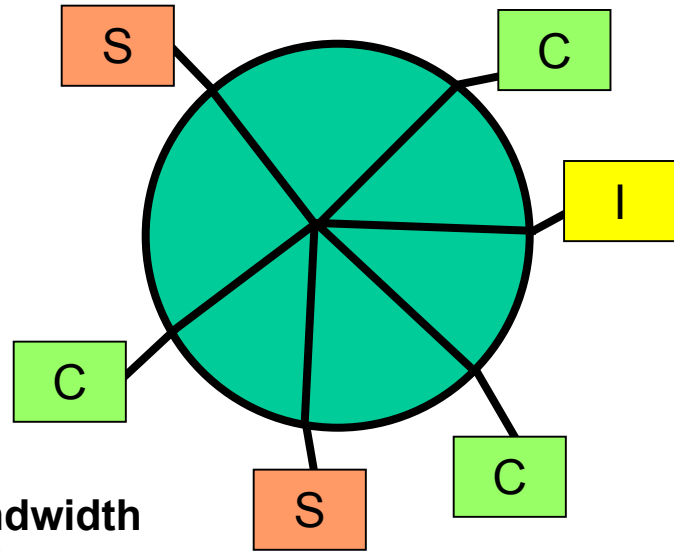
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Synchrotron Crystallography (near term)	<ul style="list-style-type: none"> • Remote observer 	<ul style="list-style-type: none"> • 		<ul style="list-style-type: none"> • Authentication, security, connection management
Sync. Crys. (5 yr)	<ul style="list-style-type: none"> • On-line data analysis using distributed computing resources • Collaboratory <ul style="list-style-type: none"> –Telepresnce –Network conferencing 	<ul style="list-style-type: none"> • Improved crystal scoring and sample monitoring for degradation and data quality • Collaborative operation of an experiment 	<ul style="list-style-type: none"> • 100 - 1000 Mbit/sec • Low latency 	
Sync. Crys. (5+ yr)		<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 500 - 5000 Mbit/sec 	

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Spallation Neutron Source (5 yr)				
SNS (5+ yr)	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 	

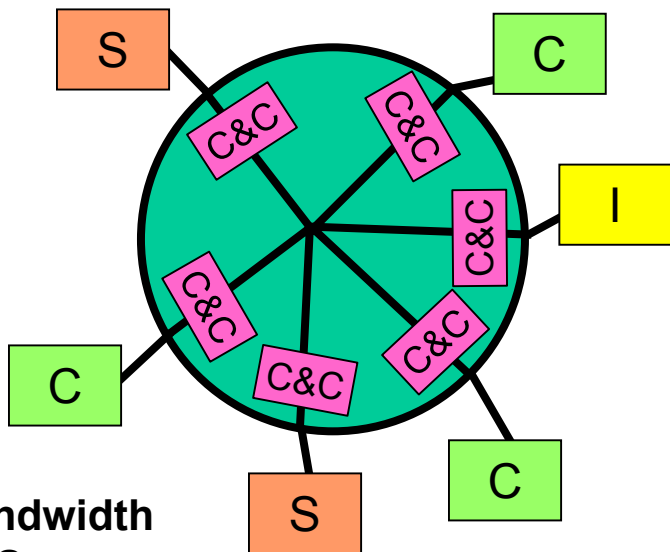
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Observational Astrophysics (near term)	•	•		
Astrophysics (5 yr)	•	•	•	
Astrophysics (5+ yr)		•		



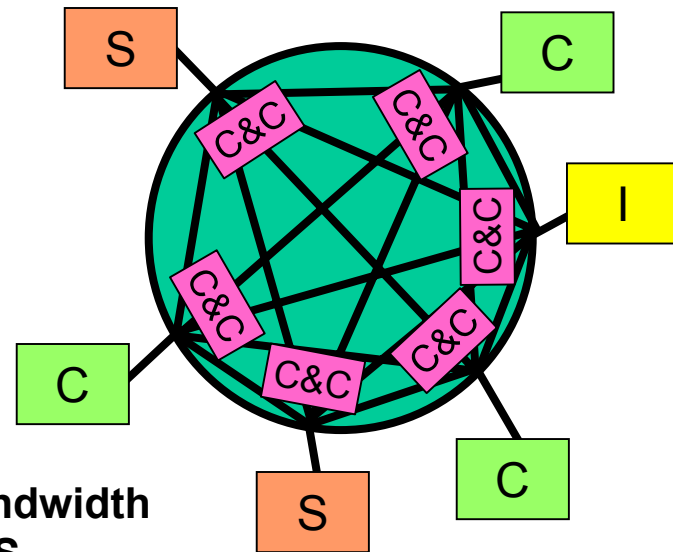
•bandwidth



•Bandwidth
•QoS



•Bandwidth
•QoS
•Network cache and compute



•Bandwidth
•QoS
•Network cache and compute
•Robust bandwidth