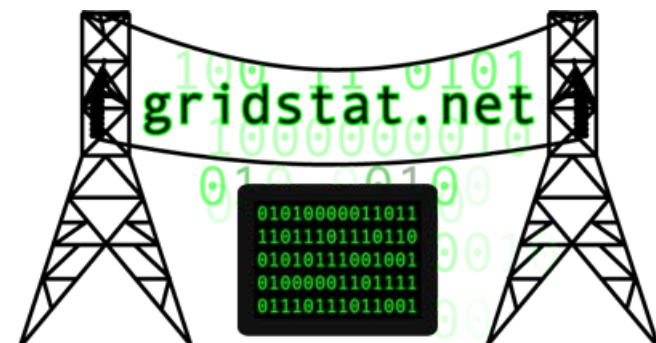


# GridStat and the NASPInet Data Bus Concept

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**NASPI Charlotte Meeting  
October 17, 2008**



# Background

- Computer science background, not power engineering....
- Anjan Bose (1999): grid's data communications are broken...
- Today: very little visibility into the real-time operations of the grid
  - *The Economist*, EPRI: “Flying Blind”
  - Major contributing factor to virtually all blackouts
- Today's *modus operandi*: send all data to a central location (control center) at the highest rate anyone might need it at
  - Worse: power grid's data communications are very hard-coded at many levels
- Caveat: I have limited time...

# What is Needed

- Francis Cleveland, Xanthus Consulting (**emphasis** ours)
  - *With the exception of the initial power equipment problems in the August 14, 2003 blackout, the on-going and cascading failures were almost exclusively due to problems in providing the right **information** to the right place within the right time.*
- Clark Gellings, EPRI (**emphasis** ours)
  - *“The **ultimate** challenge in creating the power delivery system of the 21st century is in the development of a **communications infrastructure that allows for universal connectivity.**”*
  - *“In order to create this new power delivery system, what is needed is a **national electricity-communications superhighway** that links generation, transmission, substations, consumers, and distribution and delivery controllers.”*

# What is Needed (cont.)

- Multicast (one-to-many)
- **Cyber-security**, trust management (TCIP NSF center)
- Much wider range of delivery guarantees on a per-sensor per-subscriber basis (very important)
  - Latency (delay)
  - Rate
  - Availability (# redundant paths)
- Synchronized sensor updates for synchrophasors/PMUs
- Implementable on top of fiber (directly), IP, other net. tech's
- Notes:
  - NASPInet spec RFP requirements for flexibility etc. cite GridStat
  - You **can't buy the above** today from vendors (power or IT)
  - Some major pieces in DARPA work for military

# Things to Avoid (for Fast Delivery)

- TCP/IP
  - Web Services, XML, ...
  - Commercial publish-subscribe middleware
    - Not intended for wide-area networks
    - Not fast enough (try to do too much)
    - Not enough manageability
- .... See our TR 009 at end for a lot of (CS layman) details ...

# NASPInet Architecture

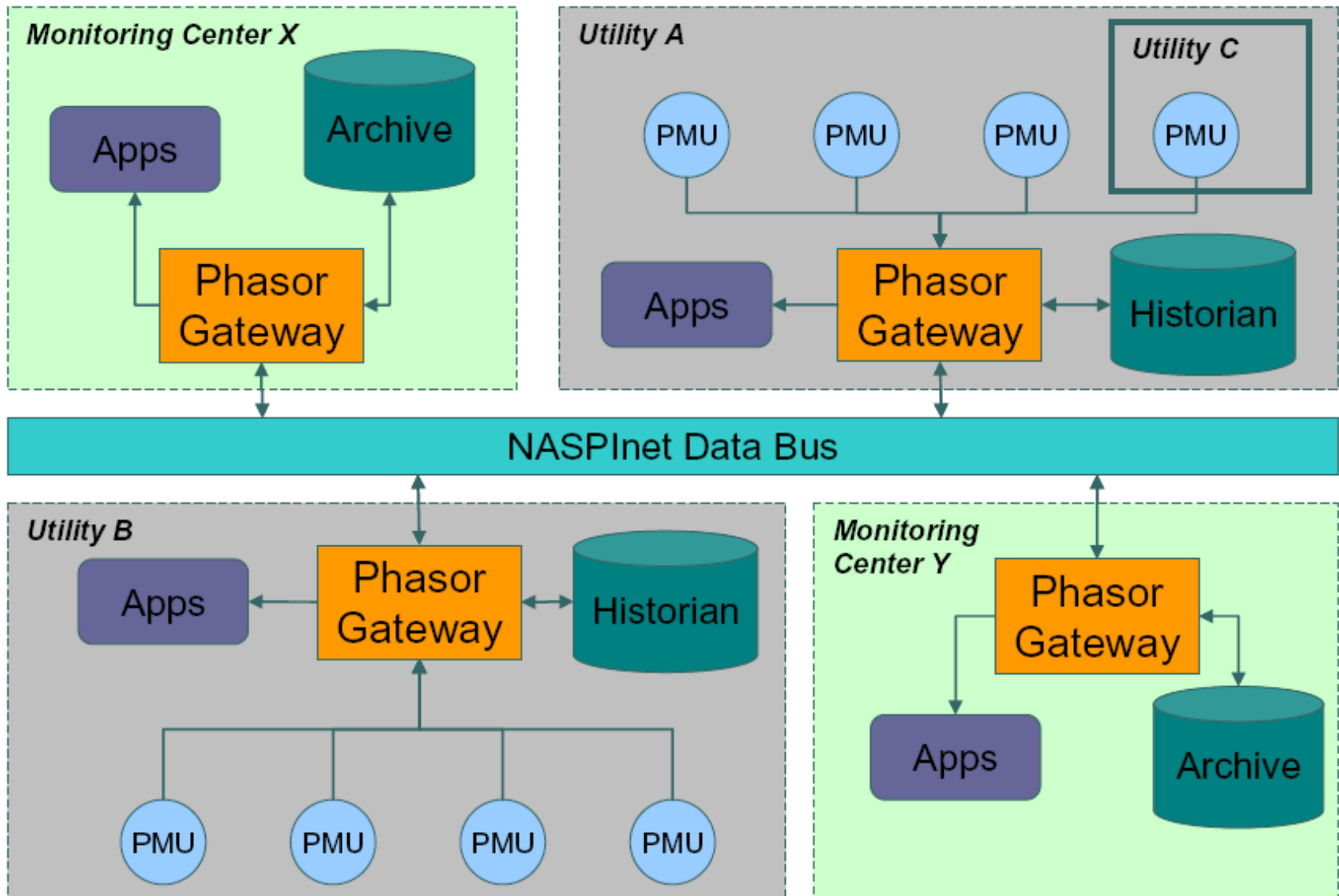
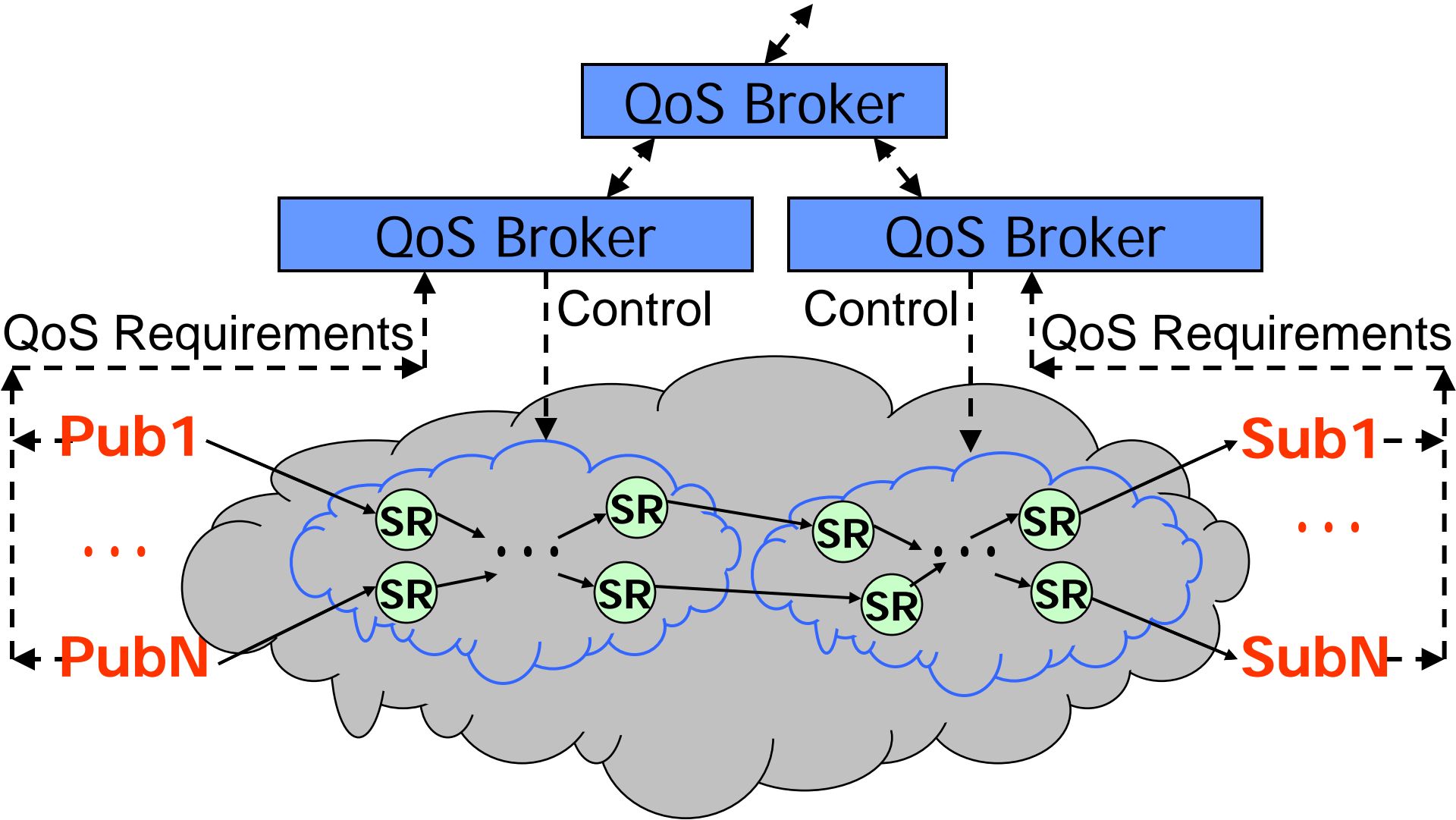


Figure 1 Basic NASPInet Architecture

**GridStat is an instance of the NASPInet Data Bus (only one so far...)**

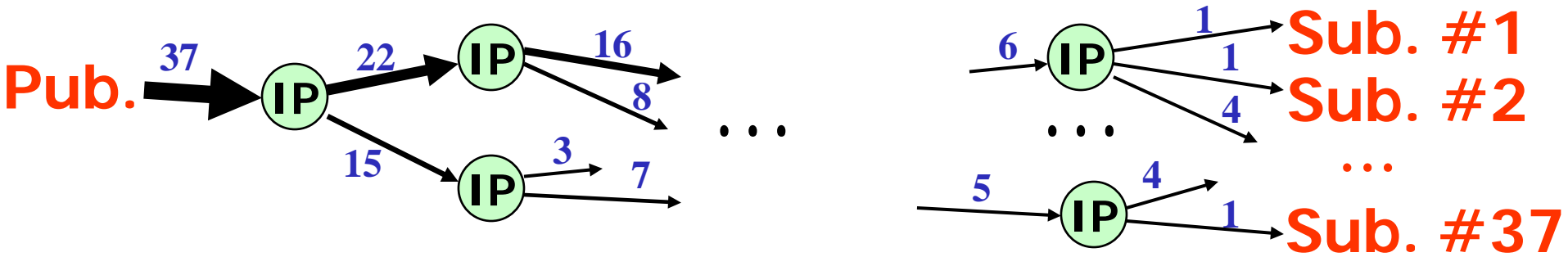
# GridStat Overview



Design: 1999+, Demo at NIST 2002, utility data 2003, PNNL-INL 2007  
Performance: very fast (<0.1 msec), scalable (100s of thousands/sec)

# A Crucial Note on Network & Publisher Load

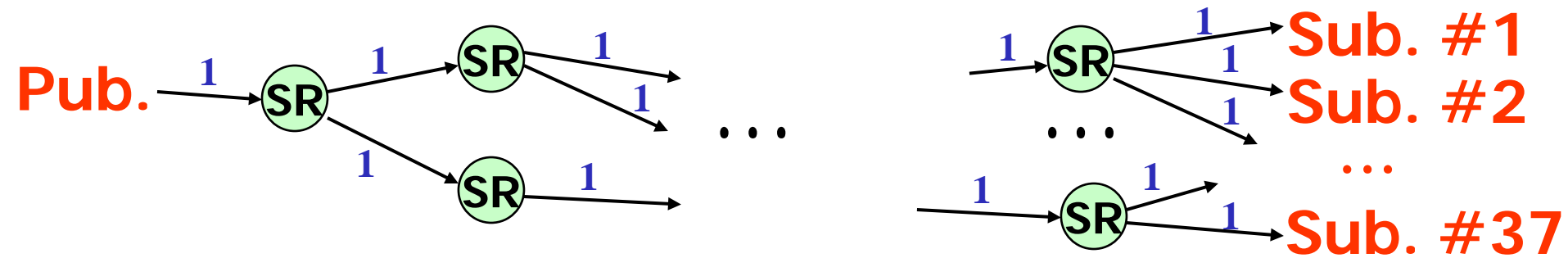
Direct network programming: up to 37 copies (#subs) of a given update:



Problems: (1) network load (2) publisher load (3) multiple encrypts

IP Multicast? (1) not everywhere (2) can't do per-sub QoS (3) single path

GridStat: 1 copy (max) of a given update on any network link:



Note: per-subscriber QoS (rate, latency, #paths) via rate filtering: if a subscriber (or subtree) does not need a given update it is not sent on



# For More Information

- <http://gridstat.net>
- **February NASPI Meeting on Phoenix: NASPInet**
- Publications
  - Carl Hauser, David Bakken, and Anjan Bose. "A Failure to Communicate: Next-Generation Communication Requirements, Technologies, and Architecture for the Electric Power Grid", *IEEE Power and Energy*, 3(2), March/April, 2005, 47–55. <http://gridstat.net/intro.pdf>
  - David E. Bakken, Carl H. Hauser, Harald Gjermundrød, and Anjan Bose. "Towards More Flexible and Robust Data Delivery for Monitoring and Control of the Electric Power Grid", *Technical Report EECS-GS-009*, School of Electrical Engineering and Computer Science, Washington State University, May 30, 2007. Available via <http://www.gridstat.net/TR-GS-009.pdf>