maintenance management systems have to be handled by custom interfaces [14].

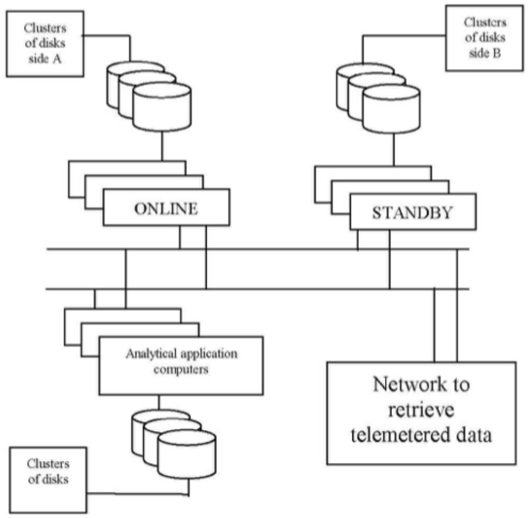

Figure 1: PCC System Diagram

Such a system has difficulties meeting the needs of a vibrant market with an unspecified number of participants needing real-time data asynchronously and at a high frequency. In addition, modern concepts of autonomy, self-reconfiguration and a self-healing power grid require distribution of data and intelligence throughout the power grid to provide fast local control responses coordinated with global analyses. In the near future, requirements for communication of real-time data in power systems can be as high as 8MByte/sec with a latency of 5msec and with time skew limited to 1msec [13]. It is in this context that we see our novel solution making an important contribution.

III. SE IN A DISTRIBUTED ENVIRONMENT

The State Estimator provides a real-time estimate of the steady-state of the entire power system network. The solution is used to monitor the power system network and is provided in a form suitable for presentation on one-line diagrams as well as in clear and compact tabular displays [10]. The State Estimator solution is also used as a base case by the other analytical applications. State Estimator provides information to help in the following functions:

- Filtering of analog measurements through a robust weighted-least squares error minimization formulation.
- Identification and removal of inconsistent analog measurements.
- Estimation of transformer tap positions.
- Estimation of Static Var Compensator output.
- Use of unpaired measurements to improve redundancy.
- Calibration of analog measurements and deviations.
- Estimation of analog measurement biases.
- Detection of inconsistent statuses (bad topology detection)
- Detection and alarming of branch overload conditions, unit and synchronous condenser limit violations, and voltage out-of range violations.

IV. SE SERVICE CENTER CONCEPT

Advances in the networking technologies have triggered one of the key industry responses, the "software as a service" initiative, also referred to as the application service provider (ASP) model. We propose an IT infrastructure to provide State Estimation as a service in an ASP business model. At present the SE is installed and maintained at each power utility's site. Instead we propose to run the SE for the entire grid at a single State Estimator Service Center (SESC) that exchanges input and output data with all other sites thus resulting in significant savings. Let's assume that we have fifty sites that bought a SE package from one vendor. In this implementation every site needs to maintain the function and have an engineer on site for any troubleshooting. Hardware, software, and network costs are decreasing constantly. People costs, however, generally, do not decrease. In the future, it is likely that computing solution costs will be dominated by people costs. In addition should any upgrades be available this change has to be propagated by the vendor to all fifty sites, installed and tested either by the vendor or by utility personnel. This is a considerable expense. If all fifty sites only send data for processing and in exchange receive the SE solution for analysis these fifty sites do not need engineers to maintain their own SE packages. The only cost is the cost of maintaining the link with the State Estimator Service Center and a fee for the service provided. The burden of maintening the SE function falls on the SE Service Center instead. This approach of course requires much less resources, and the costs are confined only to one site. From the scenario described above shows that we can have considerable savings.

The most challenging aspect of the design is to develop the SESC without compromising the current levels of response quality and availability achieved through the use of a multiplicity of control centers. The current EMS architecture consisting of an ONLINE node supplemented by a STANDBY node cannot economically meet these requirements of a grid-wide SESC.

Let's first analyze how much data we need to transfer to a SESC. For the SE function we need mostly to send measurement data once every scanning cycle. This cycle differs from user to user and can run from one to several seconds. An average size utility needs around 5000 real-time input points requiring around 100kbps. Assuming that we run SE every minute, we can see that even using a T1 line we will have our channel very loaded. Adding more Power Utilities will overload the channel even more. Over and above this requirement, occasionally Power Utilities need to upgrade