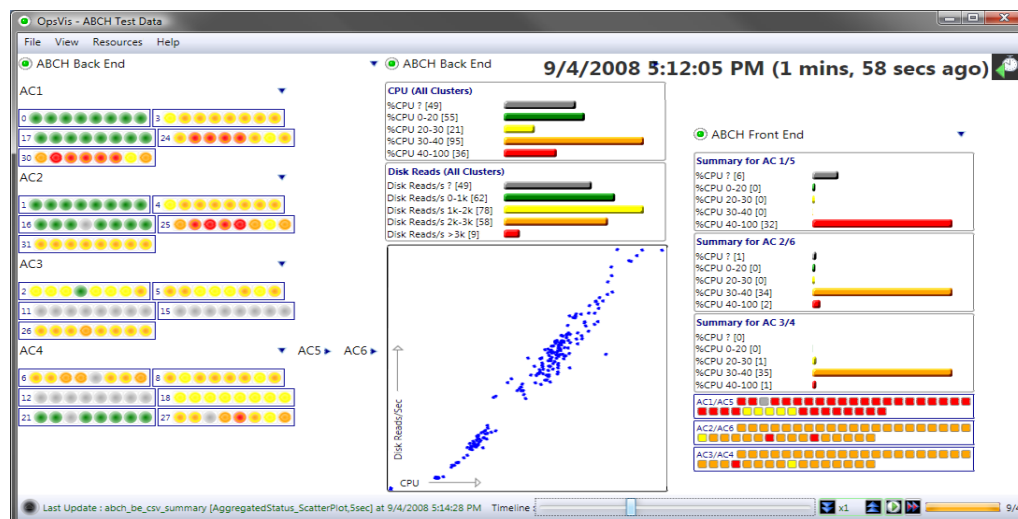


Using Visualization to Support Network and Application Management in a Data Center: *Visual-I*

Danyel Fisher
David A. Maltz
Albert Greenberg
Xiaoyu Wang
Heather Warncke
George Robertson
Mary Czerwinski



Microsoft Research

The Tier-1 Operator's Challenge

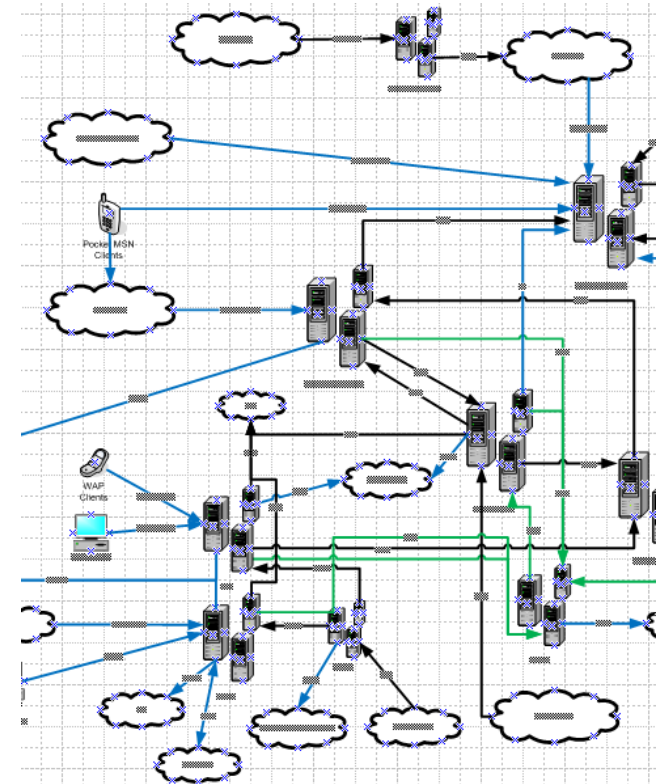
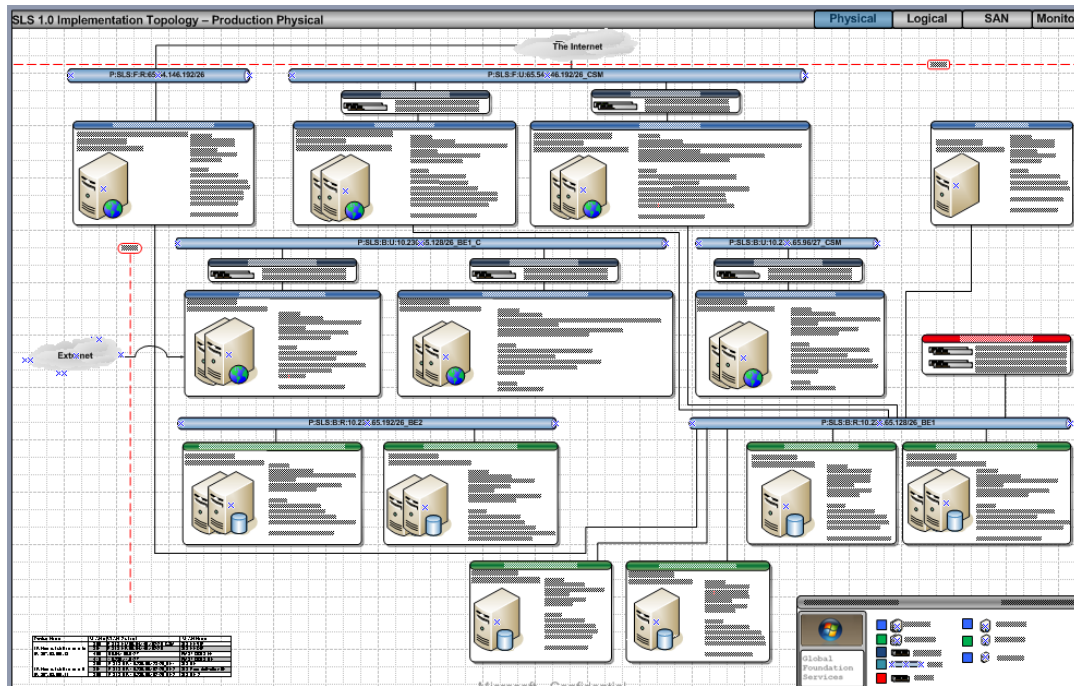
- An analyst in the SOC:
 - Hundreds of properties,
 - With a thousand events a day,
 - Across hundreds of thousands of servers,
 - With a configuration that constantly in flux,
 - And analysts who are experts in small verticals at best...



- Incidents mean lost customers and lost revenue: time to repair critical
 - Decide who to involve
 - Decide what to do

The Tier-2 Operator's Challenge

- An expert in operating a single property:
 - Deep experience with the dynamic behavior of a property
 - Not a developer – doesn't know the code; empirical, black-box knowledge
 - Responsible for running, upgrade, restoration of service



Tier-2 Tools Today

msn **MSN Transaction Monitoring**

ABCHWriteRunner

Last 24 Hrs Go

Auto-Refresh OFF Refresh

Stale Tickets: 0

Environment Production Console ALL

Open Alarms: 144 Selected Alarms: 6 Displayed Alarms: 144 Open Tickets: 0

Deselect All Create Ticket Append To Ticket Ticket Console Research Dismiss Alarm

Link Prty	Property +	Config Item	Source Application Detail	Event Count	Source Appl	Latest Event Dtim
	ADC-pdMon	BAYTRARPT40	View	2	ClusSvc	4/30/2008 20:29
	ADC-pdMon	BAYTRARPT40	View	4	ClusSvc	4/30/2008 20:29
	ADC-pdMon	BAYTRARPT40	View	1	Foundation Agents	4/30/2008 19:39
	ADC-pdMon	BAYTRARPT41	View	2	Foundation Agents	4/30/2008 19:37
	ADC-pdMon	BAYTRARPT41	View	23	Foundation Agents	5/5/2008 12:08
	ADC-pdMon	BAYTRARPT40	View	7	Foundation Agents	5/5/2008 12:08
	⊖ Asset Lost-N-Found	BAY-BC2-SN22	View DiskArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16
	⊖ Asset Lost-N-Found	BAY-BC2-SN22	View DiskArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16
	⊖ Asset Lost-N-Found	BAY-BC2-SN22	View DiskArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16
	⊖ Asset Lost-N-Found	BAY-BC2-SN22	View DiskArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16
	⊖ Asset Lost-N-Found	BAY-BC2-SN22	View DiskArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16
	⊖ Asset Lost-N-Found	BA 4/30/2008 11:16:47 PM ShortDesc: Blue-Blue-01-BLUE-01.00.0 000-Event #45106 -	View ArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16
	⊖ Asset Lost-N-Found	BA LogicalDiskBadCondition; Desc: <<<ALERTING SERVER ? [BAY-BC2-SN22] >>> LogicalDisk '7' on controller '0' has a condition of 'degraded', not 'ok'.	View ArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16
	⊖ Asset Lost-N-Found	BA	View ArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16
	⊖ Asset Lost-N-Found	BAY-BC2-SN22	View DiskArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16
	⊖ Asset Lost-N-Found	BAY-BC2-SN22	View DiskArrayMonitoringAgent	1	Hotmail - MOM	4/30/2008 23:16

PlatformRunner

Error Distribution

100% 80% 60% 40% 20% 0%

Public-ABAdd
Pvt-ABAdd
Pvt-PartitionRead
Pvt-PartitionWrite
Pvt-ABFind
Public-ABFind
Public-ABContactAdd
Pvt-ABContactAdd
Pvt-ABGroupAdd
Public-ABGroupAdd
Public-ABContactDelete
Pvt-ABContactDelete
Pvt-ABGroupContactAdd
Public-ABGroupContactAdd
Public-ABContactUpdate
Pvt-ABContactUpdate
Pvt-ABGroupContactDelete
Public-ABGroupContactDelete
Public-ABGroupUpdate
Pvt-ABGroupUpdate
Pvt-AddService
Public-AddService
Public-AddMember
Pvt-AddMember

Need to check many places to figure out what is happening

Analysis of Why Tools Fail

- **Single Perspective:** “tool per component” model taxes operators
 - One tool for a machine’s details, another tool for its connections, and query a database for its status.
 - Operators responsible for carrying context between tools (e.g., name of server)
 - Can’t see the forest for the trees (“the service for the servers”)
- **Abstraction failure:** Operators need abstractions for “chunking”
 - Operators think in hierarchies and topologies
- **Bad/Inconsistent data:** Tools must help operators cope with noise
 - Must accommodate occasional out of range or non-compliant data.
 - Threshold rules/alerts don’t work – give operator more information
 - Must cope with inconsistent meta-data

Concrete things:

- **Scalability:** tree-views don’t work for more than 100 servers
- **Monitoring overhead:** Every tool wants its own monitoring, but monitoring is already there

Visual-I Goals

Overcome the failings of previous tools

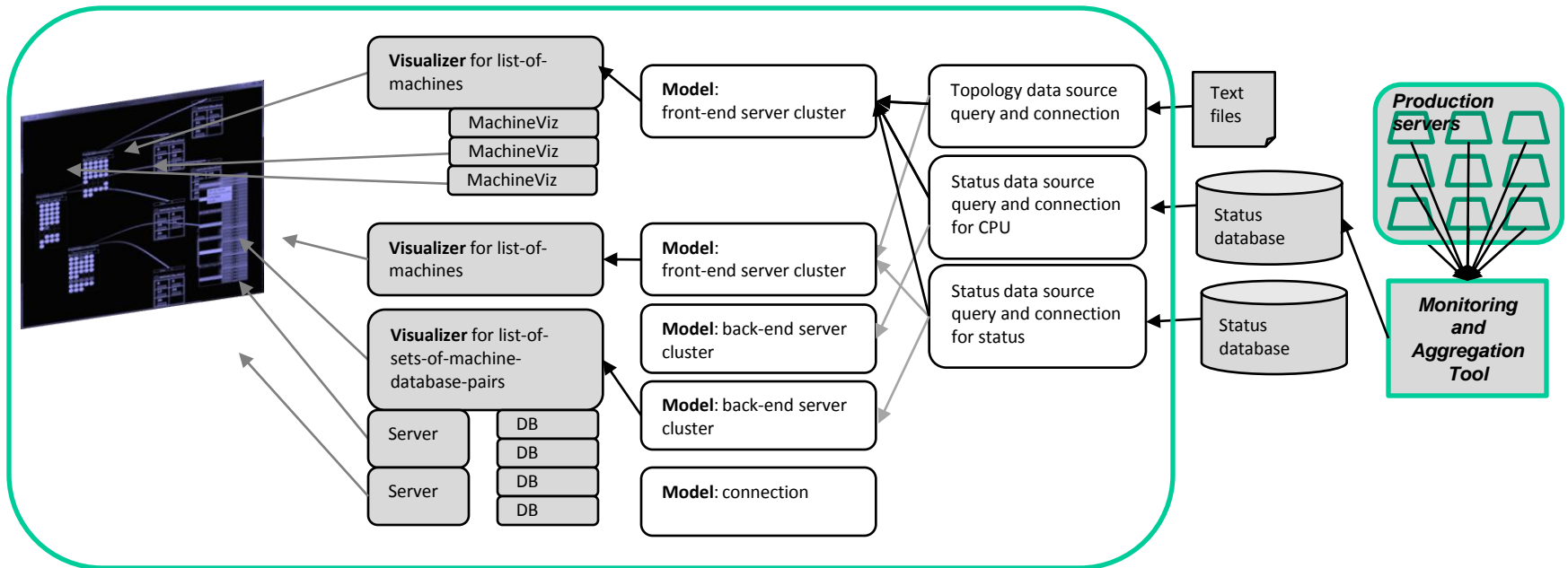
Philosophy:

- Use visualization to make instantly salient:
 - The structure of a property
 - The relationships among its parts and with other properties
- Leverage this structure to help user navigate data:
 - Request paths, volume
 - Who last worked on the box, maintenance and upgrade status
 - Temperature, CPU/Memory Utilization

Concrete things:

- Leverage existing data sources (SQL, csv, etc.)
- Be rapidly reconfigurable by the operations team itself

Data, Model View System



```
<SqlDataSource Id="BackEndStatus"
  Interpolation="LastKnown"
  ObjectKey="{server}"
  TimestampKey="{time}"
  AttributeKey="{counter}"
  ValueKey="{value}">
  <ConnectionString>Server=msr-3d-demo14;Database=O....</ConnectionString>
  <Query>
    SELECT [server], [time], [counter], [value]
    FROM   ABCHData p
    WHERE  p.[server] like '%sql%' AND p.[counter] IN ('...')
  </Query>
</SqlDataSource>

<MappedModelBuilder Id="ClusterBuilder_CSV">
  <Mapping>
    <MachineCluster Id="BaseGroup" DisplayName="ABCH Back End">
      <MachineCluster Id="{AC}" DisplayName="{AC}">
        <MachineSubCluster Id="{ClusterName}" DisplayName="{ClusterName}">
          <DatabaseServer Id="{ServerName}" DisplayName="{ServerName}" AC="{AC}">
            </DatabaseServer>
          </MachineSubCluster>
        </MachineCluster>
      </MachineCluster>
    </Mapping>
  </MappedModelBuilder>
```

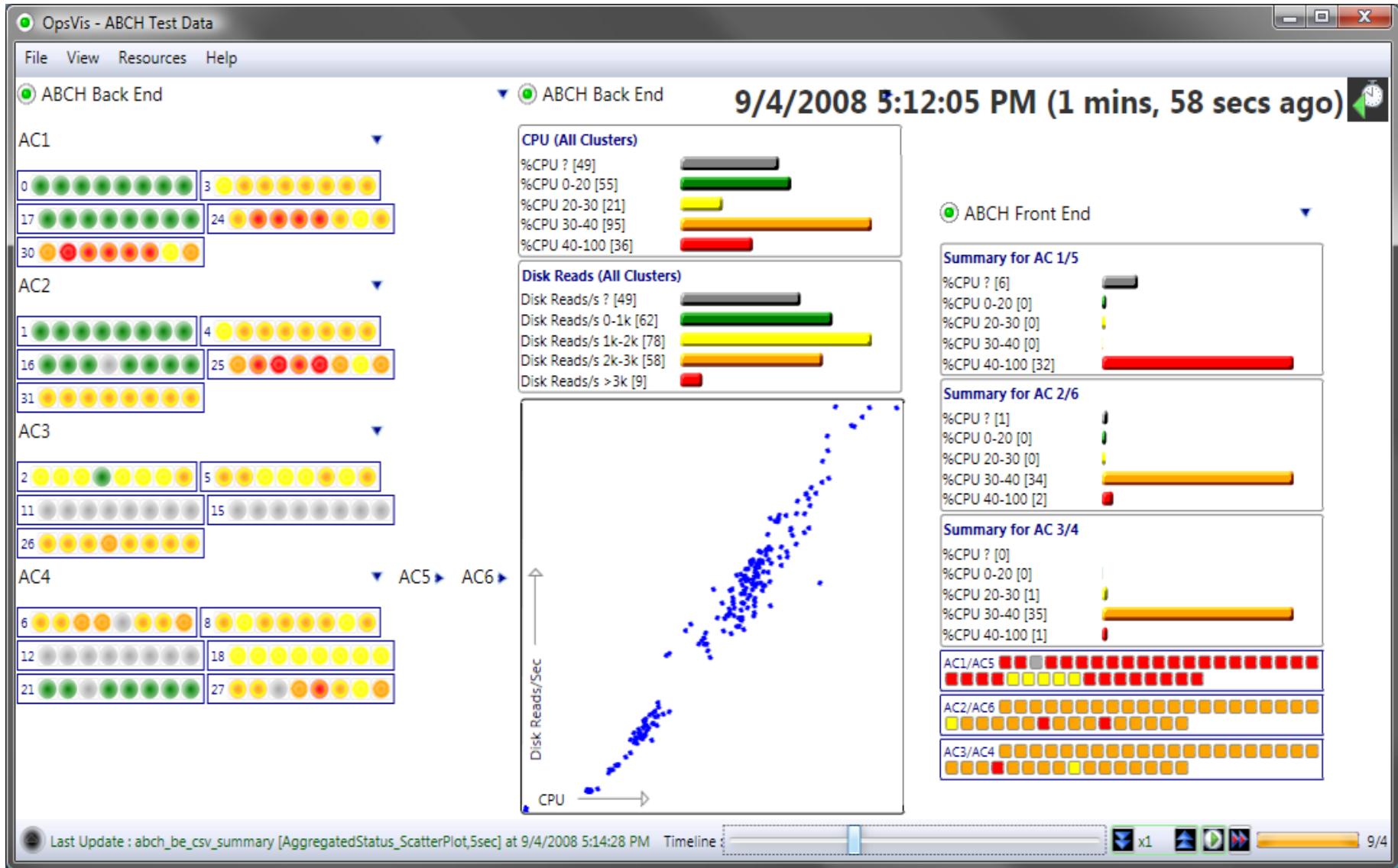


```
<MappingGroup Id="abch_map">
  <Mappings>
    <Mapping MapFrom="{CPU}"
      MapTo="ColorIndicator"
      Mapper="SteppedColorMapper"
      MapperArgs="Steps=[20,50,70,100];Colors=[Blue,Green,Orange,Red]"/>
    <Mapping MapFrom="{Trx/Sec}"
      MapTo="CenterCircleColor"
      Mapper="SteppedColorMapper"
      MapperArgs="Steps=[2000,3000,4000,10000];Colors=[Blue,Green,Orange,Red]"/>
  </Mappings>
</MappingGroup>
```

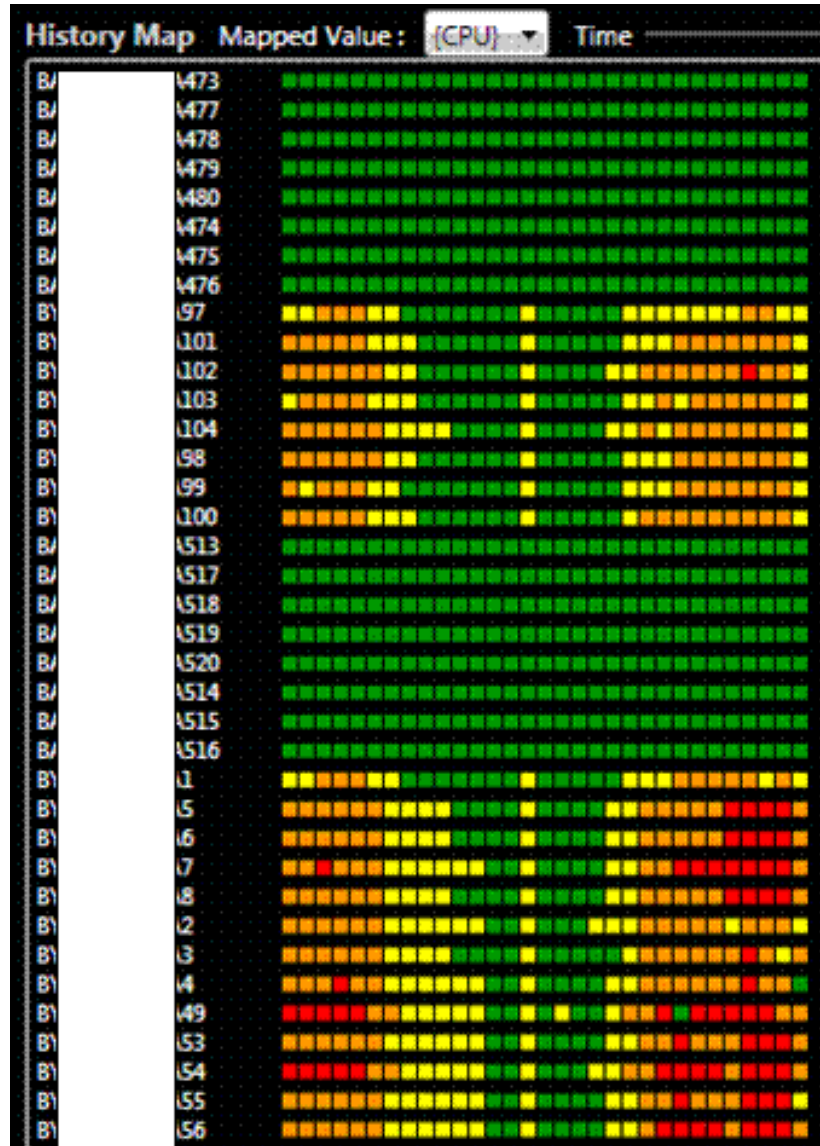
```
<ModelVisualizations>

  <ModelVisualization ModelId="abch_be_csv" VisualizationId="viz2">
    <StatusMappings>
      <Status MappingGroup="abch_map" DataSource="BackEndStatus"
UpdateFrequencySeconds="10"></Status>
    </StatusMappings>
  </ModelVisualization>
```

Visual-I Display



Visual-I History Map

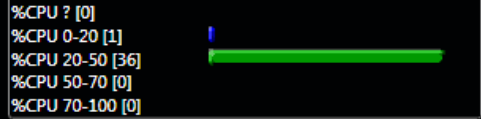


ABCH Front End

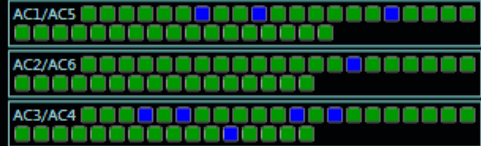
Summary for AC 1/5



Summary for AC 2/6



Summary for AC 3/4

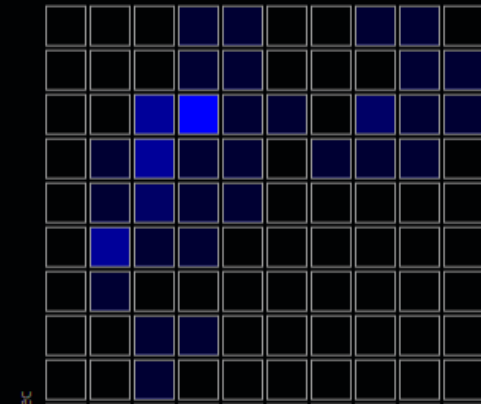
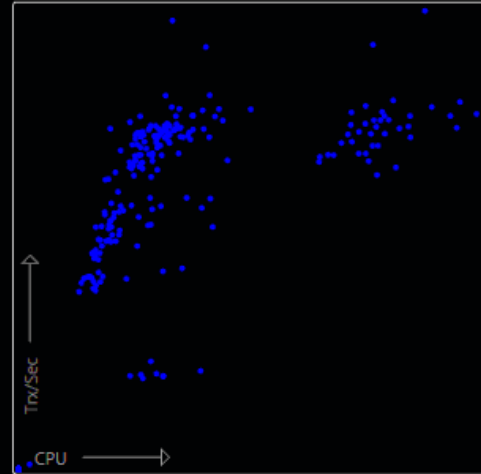


ABCH Back End

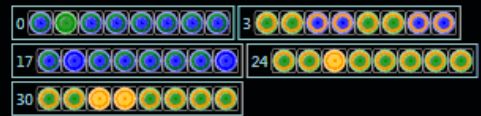
CPU (All Clusters)



Trx/s (All Clusters)



AC1



AC2



AC3



AC4

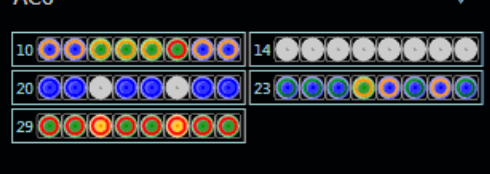
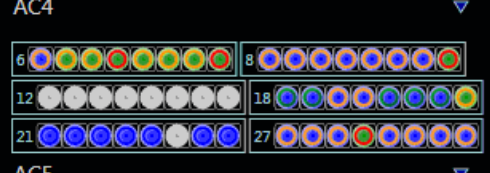
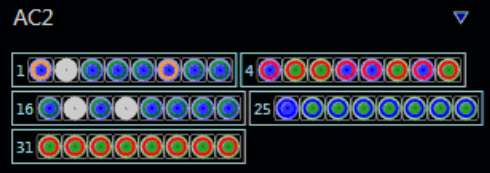
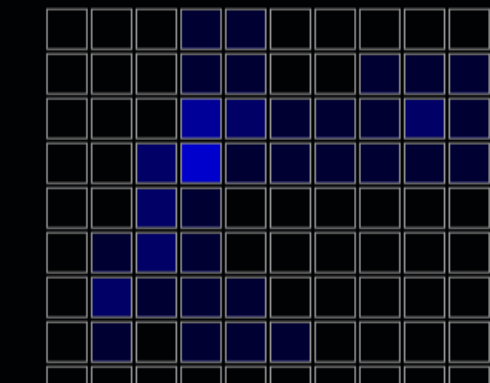
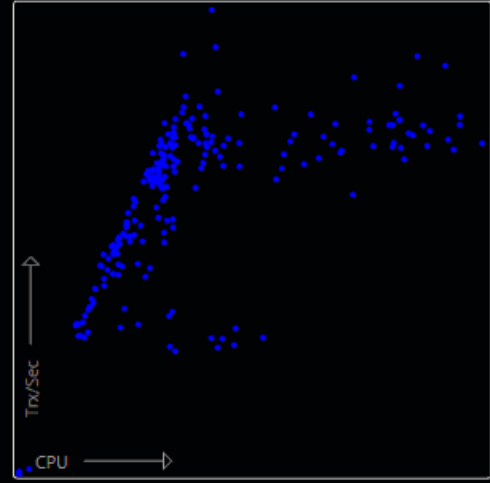
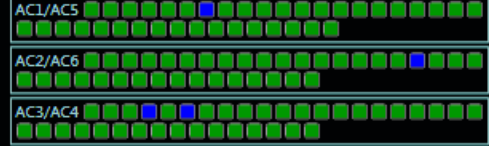
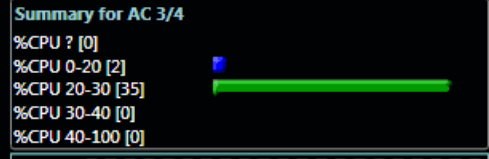
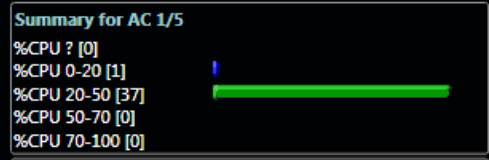


AC5

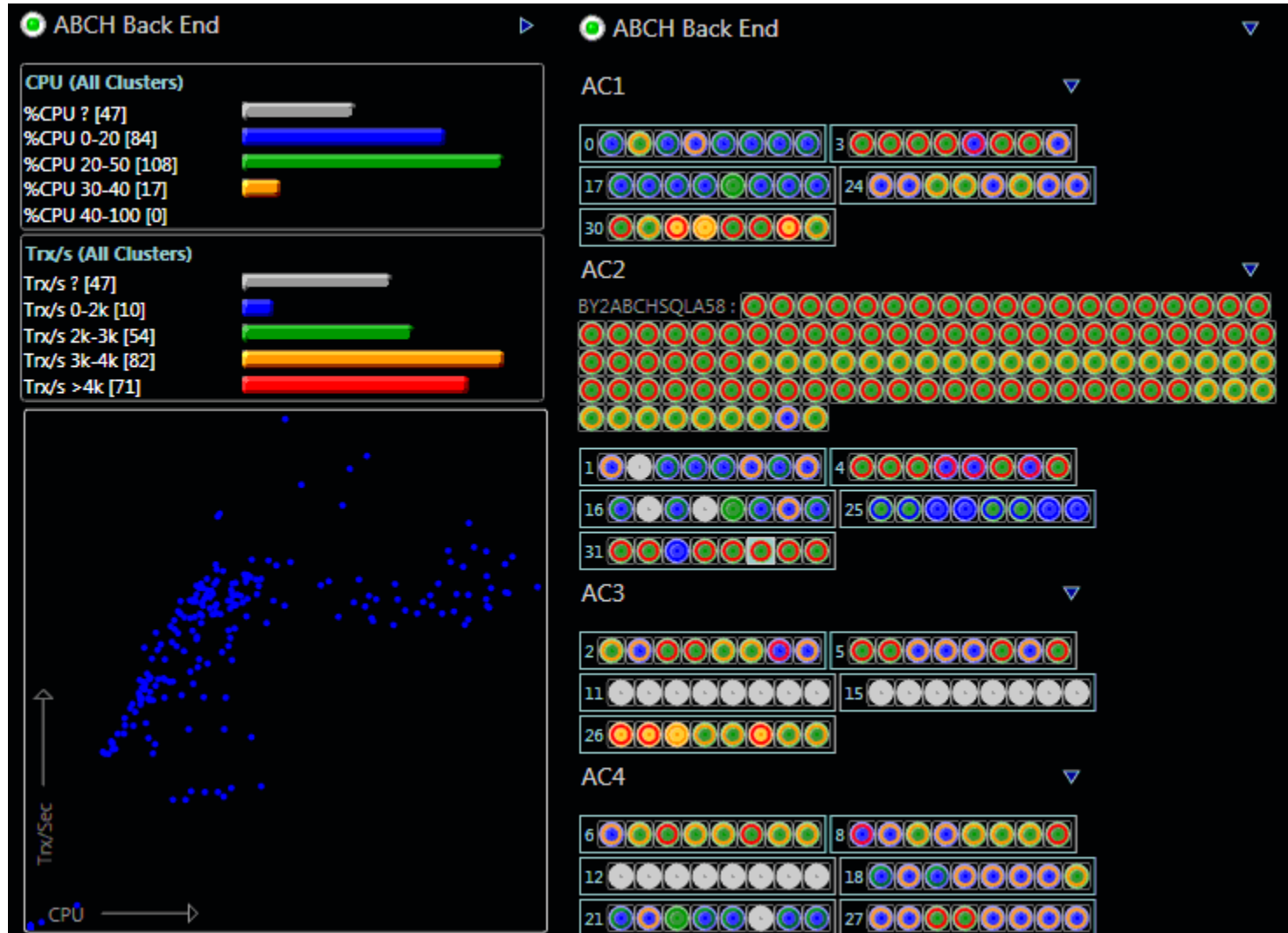


AC6

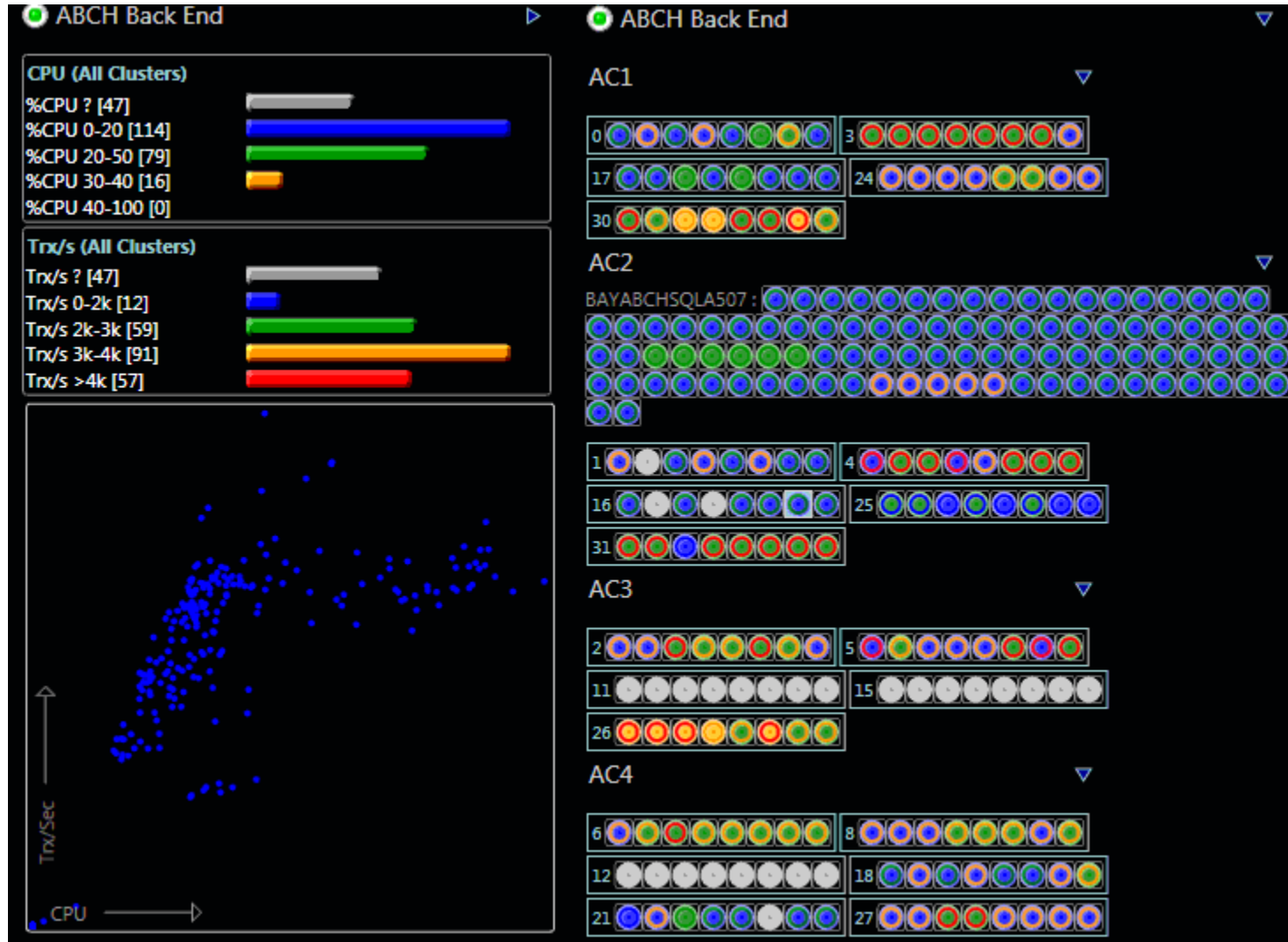




Visual-I Display

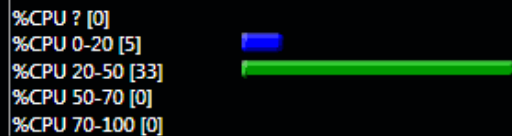


Visual-I Display

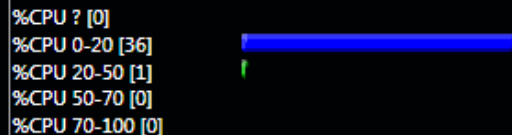


ABCH Front End

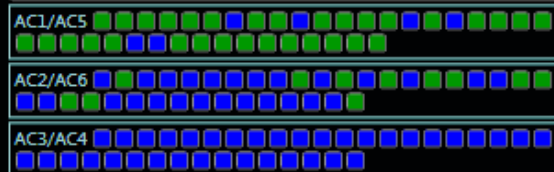
Summary for AC 1/5



Summary for AC 2/6



Summary for AC 3/4

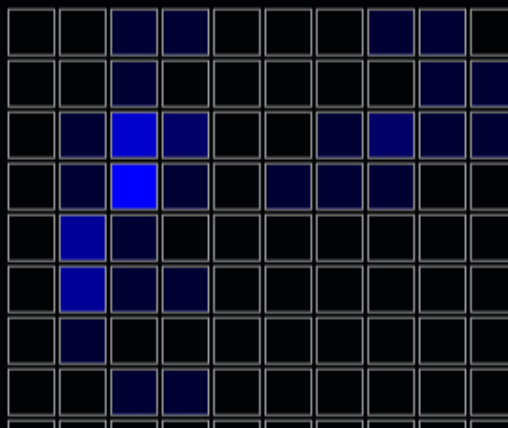
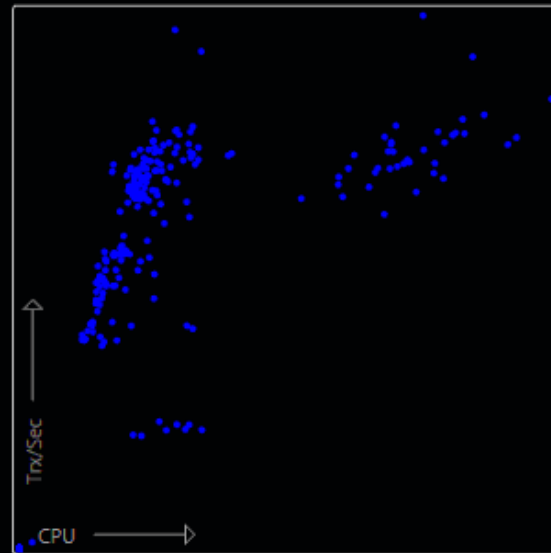


ABCH Back End

CPU (All Clusters)



Trx/s (All Clusters)

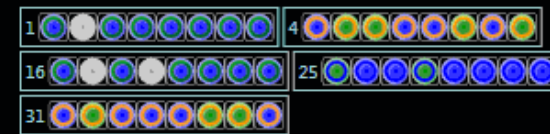


ABCH Back End

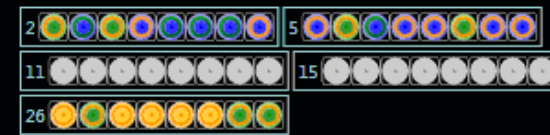
AC1



AC2



AC3



AC4



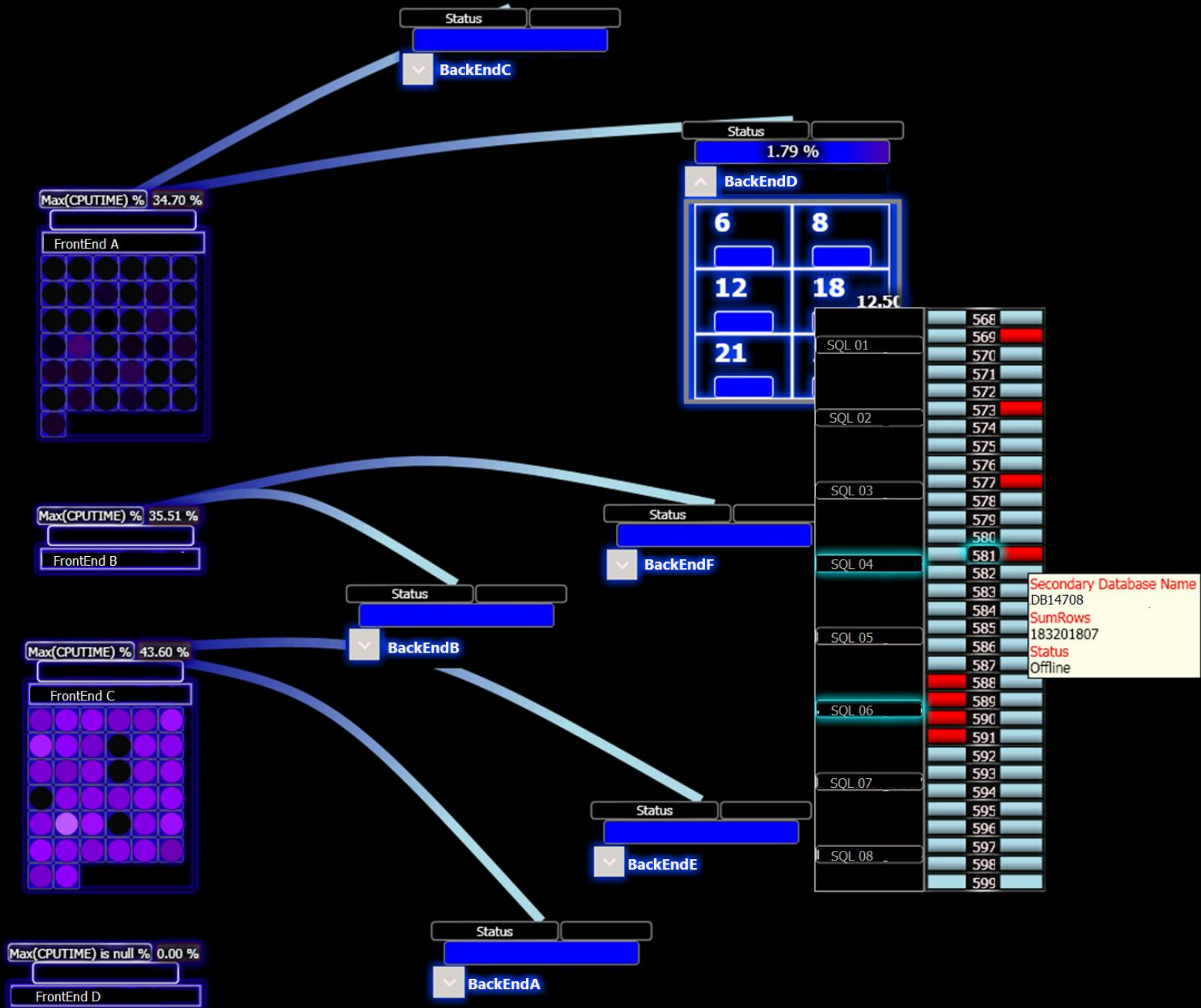
AC5



AC6



	0	
SQL478	1	
	2	
	3	
	4	
SQL479	5	
	6	
	7	
	8	
SQL480	9	
	10	
	11	
	12	
SQL481	13	
	14	
	15	
	16	
SQL482	17	
	18	
	19	
	20	
SQL483	21	
	22	
	23	
	24	
SQL484	25	
	26	
	27	
	28	
SQL485	29	
	30	
	31	



Some Future Directions

- Coping with meta-data anomalies through multiple interpretations
- Better visualizations for relationships between components
 - Current visualizations get too busy if lines are used
 - Not clear if box layouts are general enough
- Longitudinal study of Visual-I in use

Summary

Visualization tools can help operators:

- ***Understand*** the current state of the system
 - Even when the system is in an inconsistent or an unusual state
- ***Discover correlated behaviors*** critical to debugging the system
- ***Deal with inconsistencies***
 - Rules and autonomic tools have difficulty when the structure of the application does not fit the assumptions of the management system

Key features to provide are:

- Make the visuals follow the operator's mental models of the system
- Enable correlation by providing context
 - Show same item but multiple instants in time
 - Show multiple items but functionally related