CyPSA

Cyber Physical Security Analysis

PowerWorld WECC User's Group Meeting

March 16, 2016

ILLINOIS

Oregon State UNIVERSITY

RUTGERS UNIVERSITY

PowerWorld Corporation

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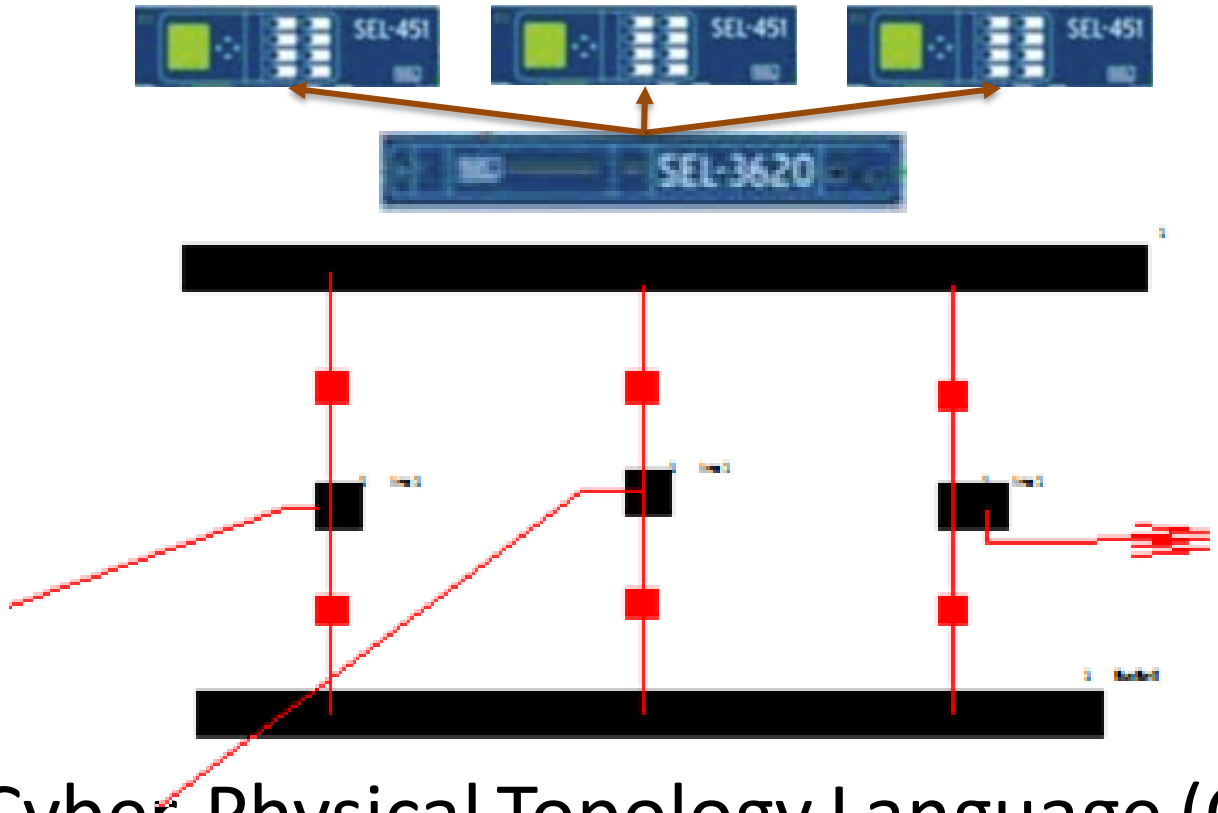
http://publish.illinois.edu/iti-cypsa/

Inventory Management



Cyber-Physical Topology Language (CPTL) :
https://github.com/ITI/cptl-power/wiki

New PowerWorld Objects

- **CyberDevices**: Access breakers via their respective relays
- **CyberLinks**: Connections
- AUX format and CPTL JSON support

New PowerWorld Objects

- Process “TRIP” relay outputs and breaker connections
- Interface with CyPSA via socket protocol
- New “OpenFromCyber;” script command

OpenAllFromCyber([CyberDevice “xx.xx.xx.xx"]);

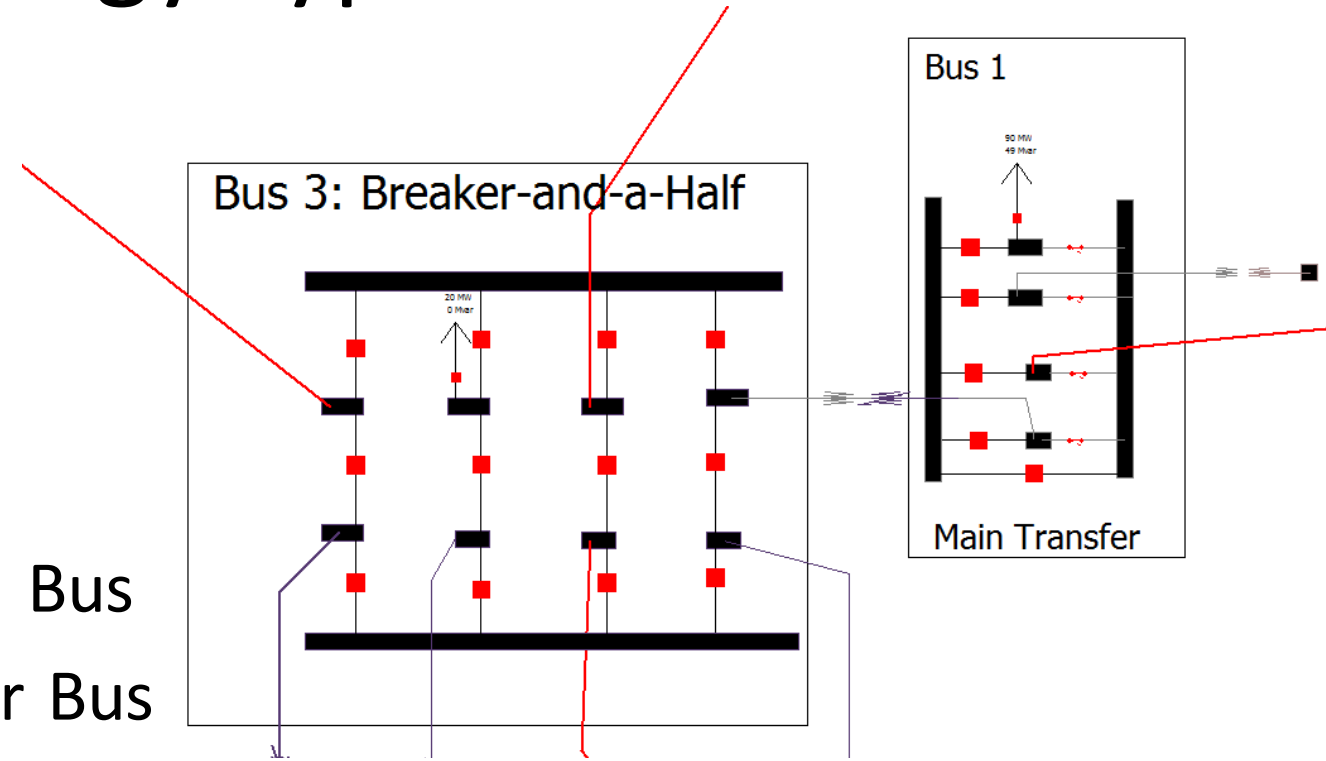
Relays, LORs, Comm. Proc. Support

- When a ***Lock-out-Relay (LOR)*** is encountered, look up its identifier in the case's cyber objects, and obtain the list of connected breakers

- ***Communications processors*** are treated similarly

- State the name or address of the device to be accessed in the output field following the "TRIP" keyword:
  - "TRIP comm procx."

Six Topology Types in Simulator



- Single Bus
- Sectionalized Bus
- Main Transfer Bus
- Ring Bus
- Breaker and a Half
- Double Bus Double Breaker

Power Topology Model Expansion

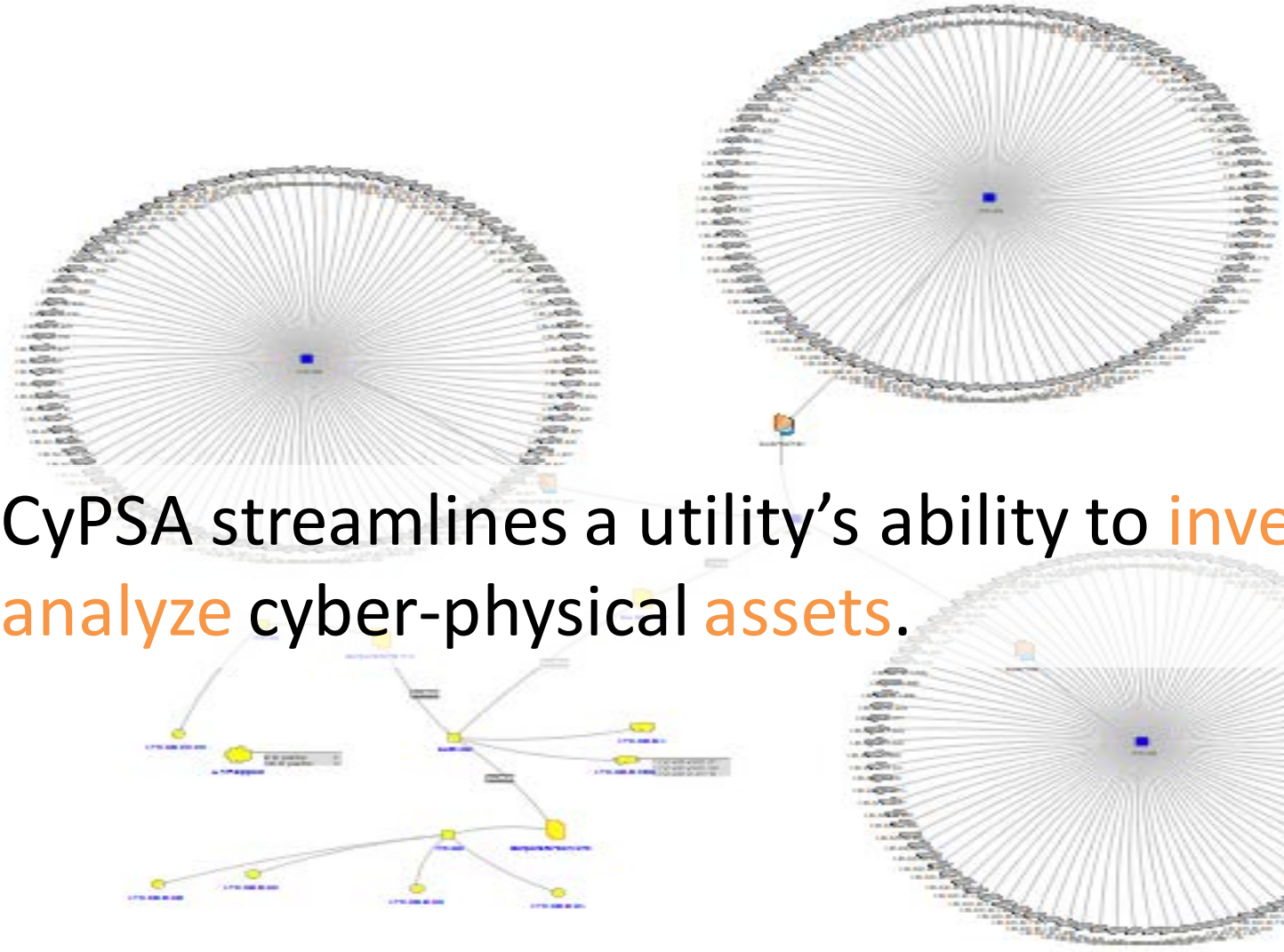
- New script commands
  - *ExpandAllBusTopology;* – convert all bus topologies to types indicated in the custom string 5 field
  - *ExpandBusTopology(Bus ID, Topology Type);* - convert single bus to the indicated type

Protection Templates for Model Expansion

- Relay configurations created for each bus topology
- Execute *ExpandBusTopology();* WITH interconnections
- Export results in any format; i.e., ***CPTL***
- Takes manual effort out of assigning interconnections for academic study

PowerWorld Cyber Connectivity

- Cyber object support is intended to help users
  - Develop and test ***realistic*** templates for protection layouts
  - ***Manually assign*** protection layouts
  - ***Map*** RTU/relay device to cyber network IP
  - Perform cyber-physical analysis and situational awareness: ***CyPSA***



CyPSA streamlines a utility's ability to inventory and analyze cyber-physical assets.

Use Case: Asset Ranking

Description	Analyze all attack paths for a given set of assets Rank based on both *impact* and *cyber exposure* • *Impact*: power system performance index based on severity metrics • *Cyber exposure*: metrics include the number of potential attack paths and ease of realizing an attack
Role	**Manager**
Inputs	• A model • A source of vulnerability information • A set of assets to be ranked
Outputs	• A list of attack paths annotated with and ordered by a ranking

CyPSA Control Panel

CyPSA Home Model Action Panin

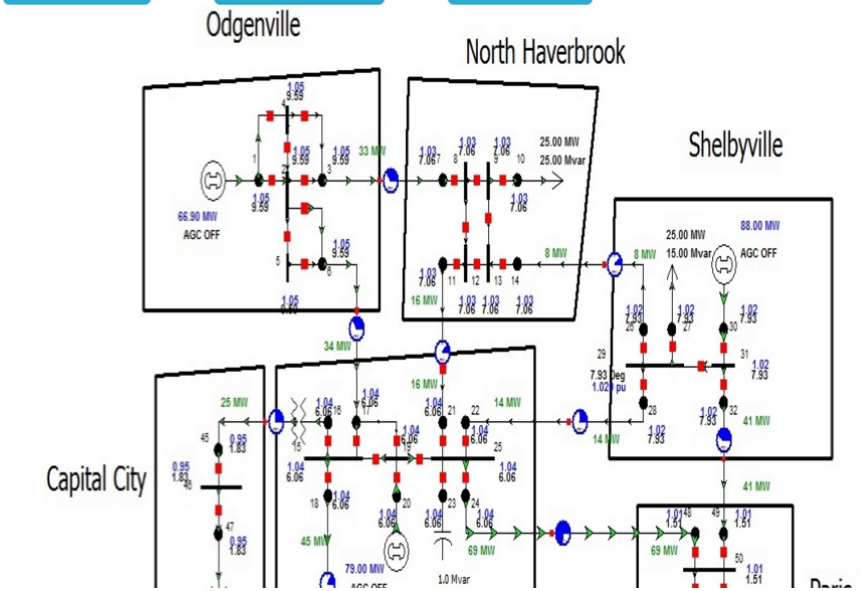
Home / Cypsa Analysis Project

IP Address	Type	Performance Index (Curr/Prev)	Cyber Cost (Curr/Prev)	Security Index (Curr/Prev)
10.31.1.103	destination	85.50/85.50	279.38/279.38	7.15/7.15
10.31.1.102	destination	49.10/49.10	279.38/279.38	4.10/4.10
10.39.1.22	intermediate	70.97/70.97	654.39/654.39	3.90/3.90
10.31.1.101	destination	30.34/30.34	279.38/279.38	2.54/2.54
10.31.1.104	destination	30.35/30.35	279.38/279.38	2.54/2.54
10.31.1.105	destination	34.57/34.57	279.38/279.38	2.89/2.89
70.32.128.171	source	11.83/11.83	67.53/67.53	1.16/1.16
70.32.128.22	source	11.83/11.83	67.53/67.53	1.16/1.16
70.32.128.74	source	11.83/11.83	67.53/67.53	1.16/1.16
10.39.1.22	source	11.83/11.83	57.53/57.53	1.23/1.23
10.31.1.203	source	10.45/10.45	54.98/54.98	0.95/0.95
10.31.1.202	source	10.45/10.45	54.98/54.98	0.95/0.95

javascript:void(0);

Select Project

View Cyber | View Physical | View Paths



Use Case: Patching

Description	Select hosts or vulnerabilities to patch and re-compute attack path rankings.
Role	IT Administrator Manager
Inputs	• A model • A source of vulnerability information • A set of assets to be ranked
Outputs	A list of attack paths whose rankings have been updated based upon which assets were patched.

Mark devices patched then recalculate ranking

CyPSA Home | Model | Action | Panini

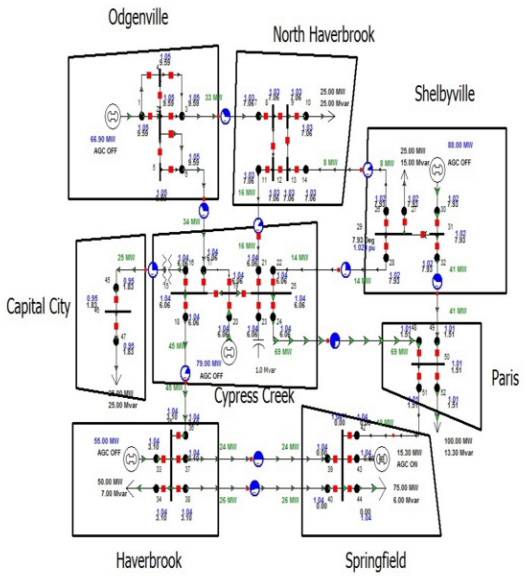
Ranked Assets

Show 10 entries Search:

IP Address	Type	Performance Index (Curr/Prev)	Cyber Cost (Curr/Prev)	Security Index (Curr/Prev)
10.31.1.101	destination	1.38/1.38	8.95/8.95	0.15/0.15
10.31.1.102	destination	2.23/2.23	8.95/8.95	0.25/0.25
10.31.1.103	destination	3.89/3.89	8.95/8.95	0.43/0.43
10.31.1.104	destination	1.38/1.38	8.95/8.95	0.15/0.15
10.31.1.105	destination	1.57/1.57	8.95/8.95	0.18/0.18
10.31.1.201	source	10.45/10.45	44.76/44.76	1.17/1.17

Showing 1 to 6 of 6 entries Previous 1 Next

View Cyber | View Physical | View Paths



Patched Hosts | Compromised Hosts | Vulnerabilities

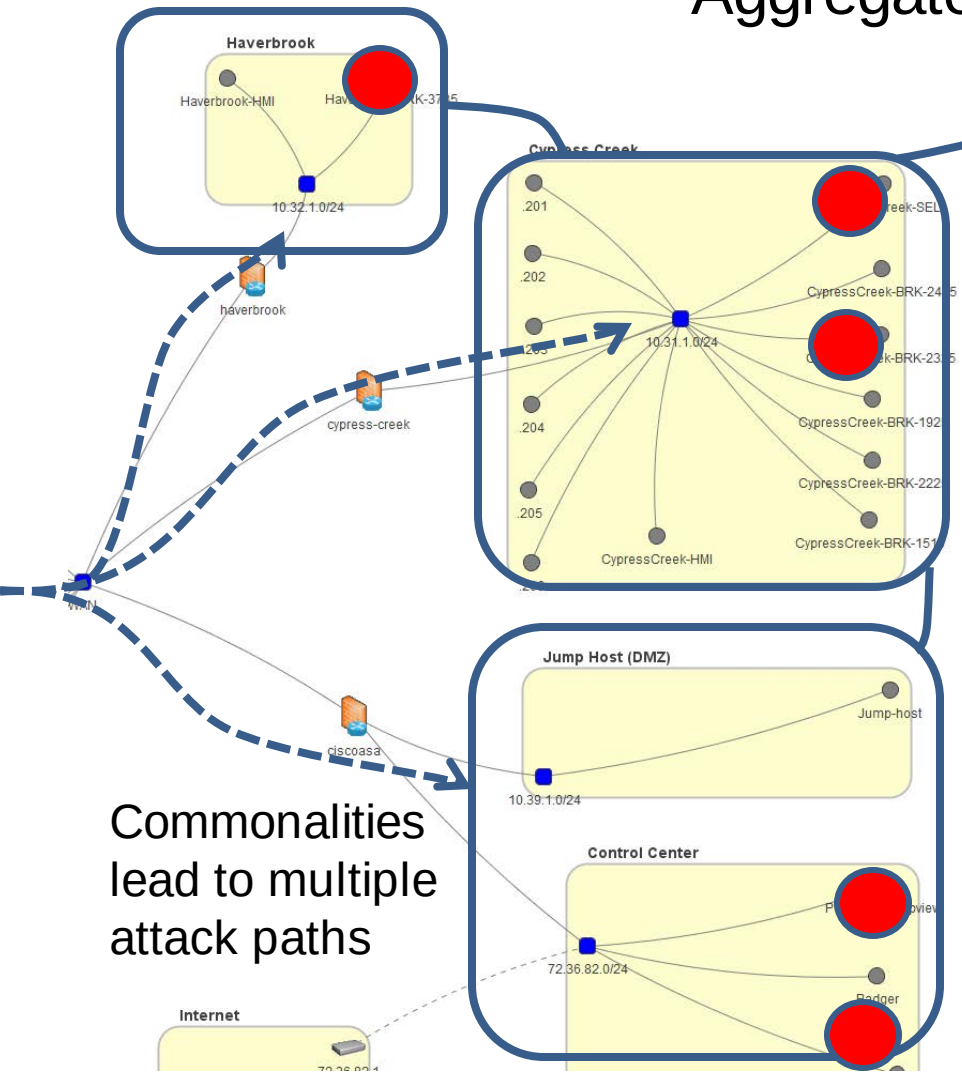
Select	IP Address	Vulnerabilities
☐	10.31.1.103	CVE-2015-4195
☐	10.31.1.102	CVE-2015-2907
☐	10.31.1.105	CVE-2015-2906
☐	10.31.1.104	CVE-2015-4195
☐	10.31.1.101	CVE-2015-4195

Patch Selected Hosts

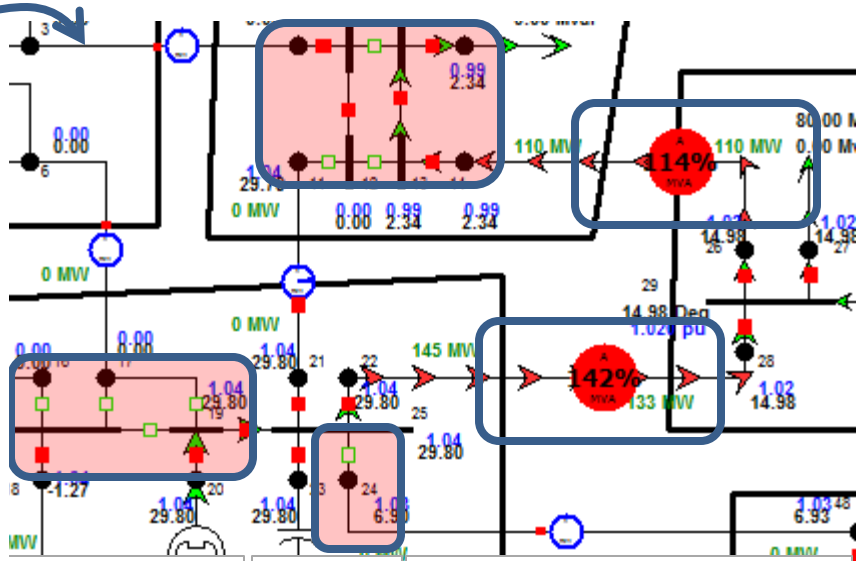
Use Case: Aggregate Exposure

Description	Analyze all attack paths for a given grouping of assets, e.g. all paths through assets of a given type or with a given vulnerability that lead to another asset of a given type (i.e., breakers). Rank based on both *impact* and *cyber exposure*
Role	**Manager**
Inputs	• A model • A source of vulnerability information • A set of assets to be ranked
Outputs	• A list of attack paths annotated with and ordered by a ranking

Aggregate Exposure



Commonalities lead to multiple attack paths



Vulnerability ID	Frequency	Select Hosts
CVE-2013-4581 -	60	Select All Cypress Creek-BRK-2425 - 10 Cypress Creek-BRK-1519 - 10 Haverbrook-BRK-3735 - 10 Cypress Creek-BRK-2325 - 10
CVE-2015-0667 -	13	Select All Cypress Creek-BRK-2425 - 12 Cypress Creek-BRK-2225 - 1

Use Case: Cyber Incident Planning

Description	Devices are marked as compromised and asset rankings are re-computed.
Role	**IT Administrator** **Manager** **Power Engineer**
Inputs	• A model • A source of vulnerability information • A set of assets to be ranked
Outputs	A list of assets whose rankings have been updated based upon which assets were compromised.

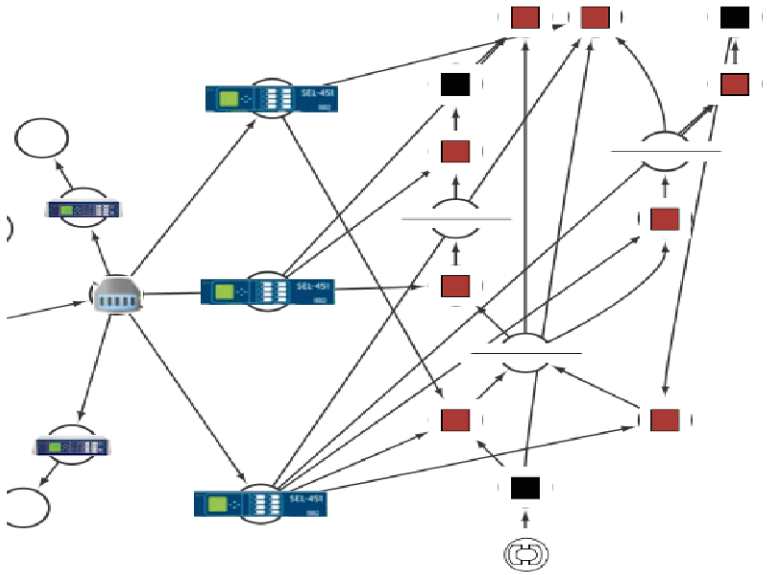
Annotation, Vulnerability Information: Manager

Annotate Model

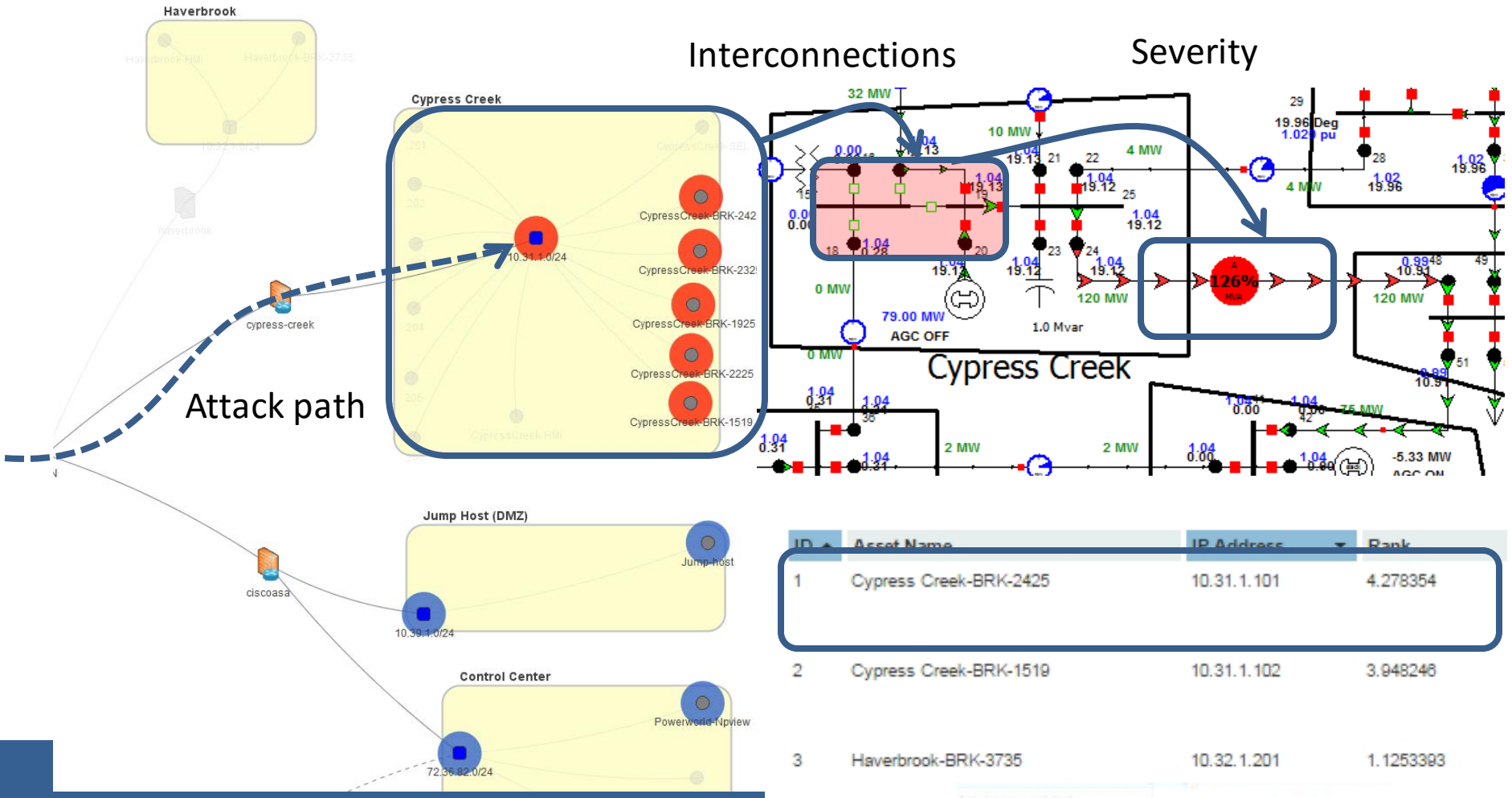
Name	OS	CVE Vulns	Freq
SEL 3620 1			
SEL 421 1			
SEL 421 2			
...			
SEL 451 1			
...			

Load annotations data
on CVE Vulns
from URL or Path to Annotation
Join on OS
GO

Cypress Creek, Substation Network



Beyond ‘N-1’
transient stability analysis using a cyber incident



ID	Asset Name	IP Address	Rank
1	Cypress Creek-BRK-2425	10.31.1.101	4.278354
2	Cypress Creek-BRK-1519	10.31.1.102	3.948246
3	Haverbrook-BRK-3735	10.32.1.201	1.1253393

DEMO

- Start-up partnering with Powerworld and SEL
- Provides support and installation for CyPSA
- Commercial client kaedago for relay cyber/physical tie information

Take Action

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