

Assessing the Impact of Wide-Area Protection Schemes on Performance and Reliability of Electrical Power Systems



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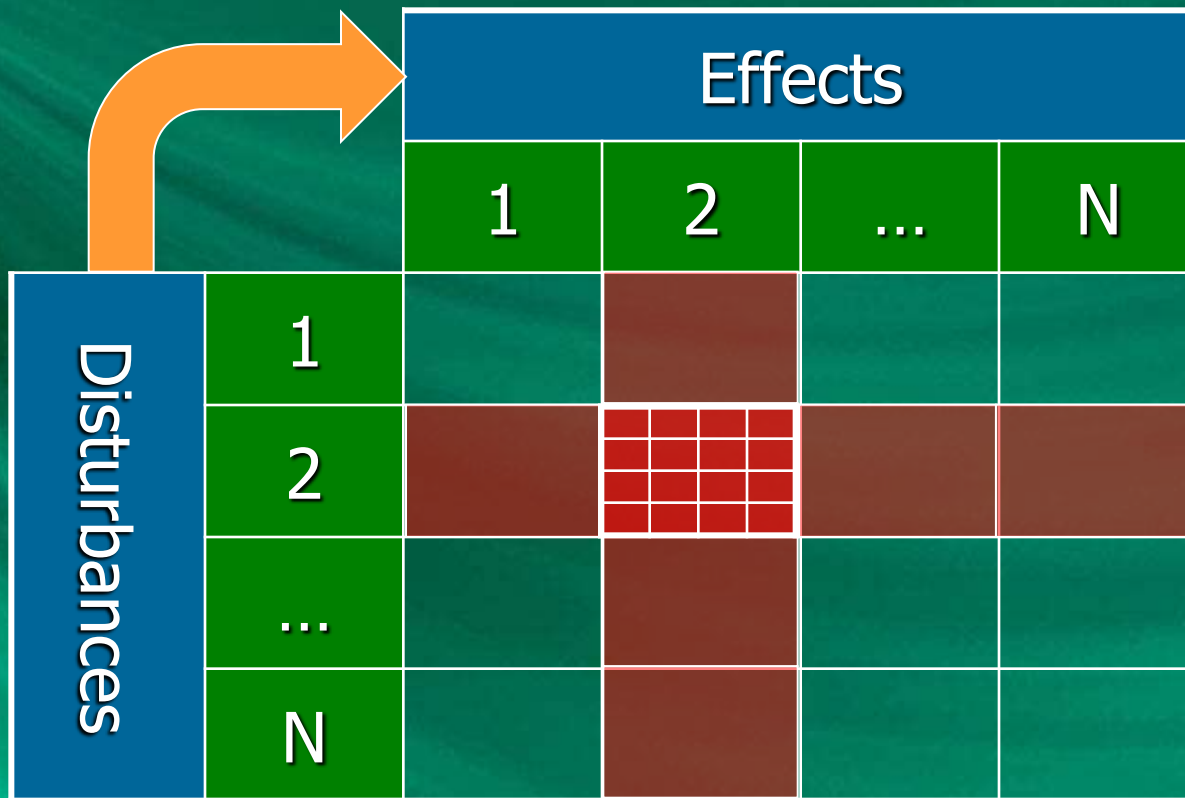
Actual Trends in Development of
Power System Relay Protection and Automation
01 – 05 June 2015, Sochi

To present a method to evaluate expected changes of power system **performance and reliability indexes**, due to the contribution of **wide-area protection schemes**



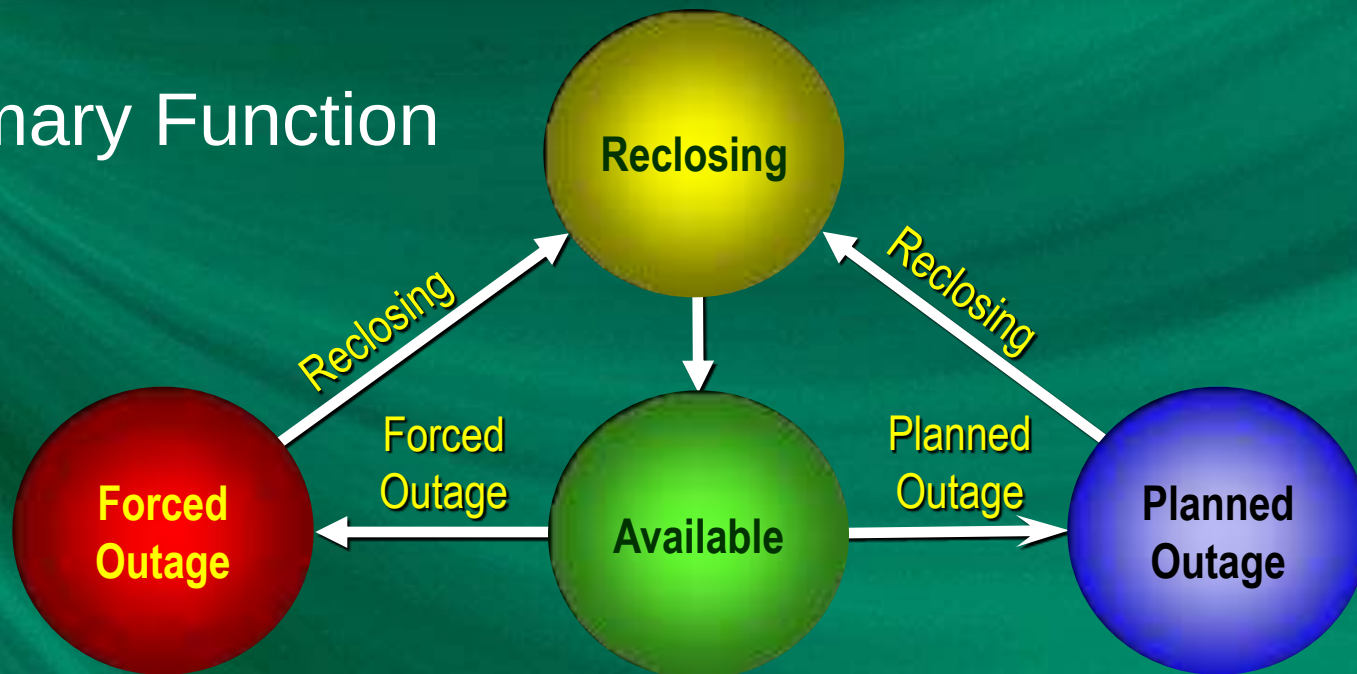
Disturbance Cross Impact Model

Sochi - 2015

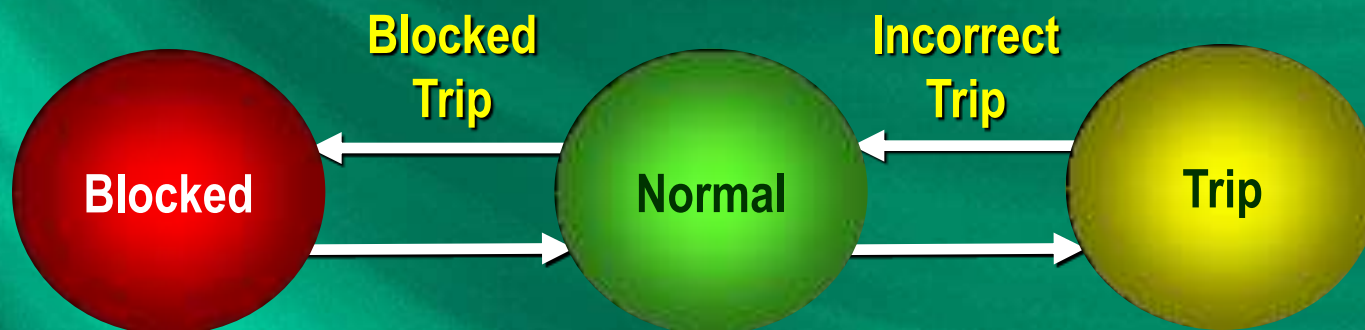


Models of Primary and Protection Functions

Primary Function

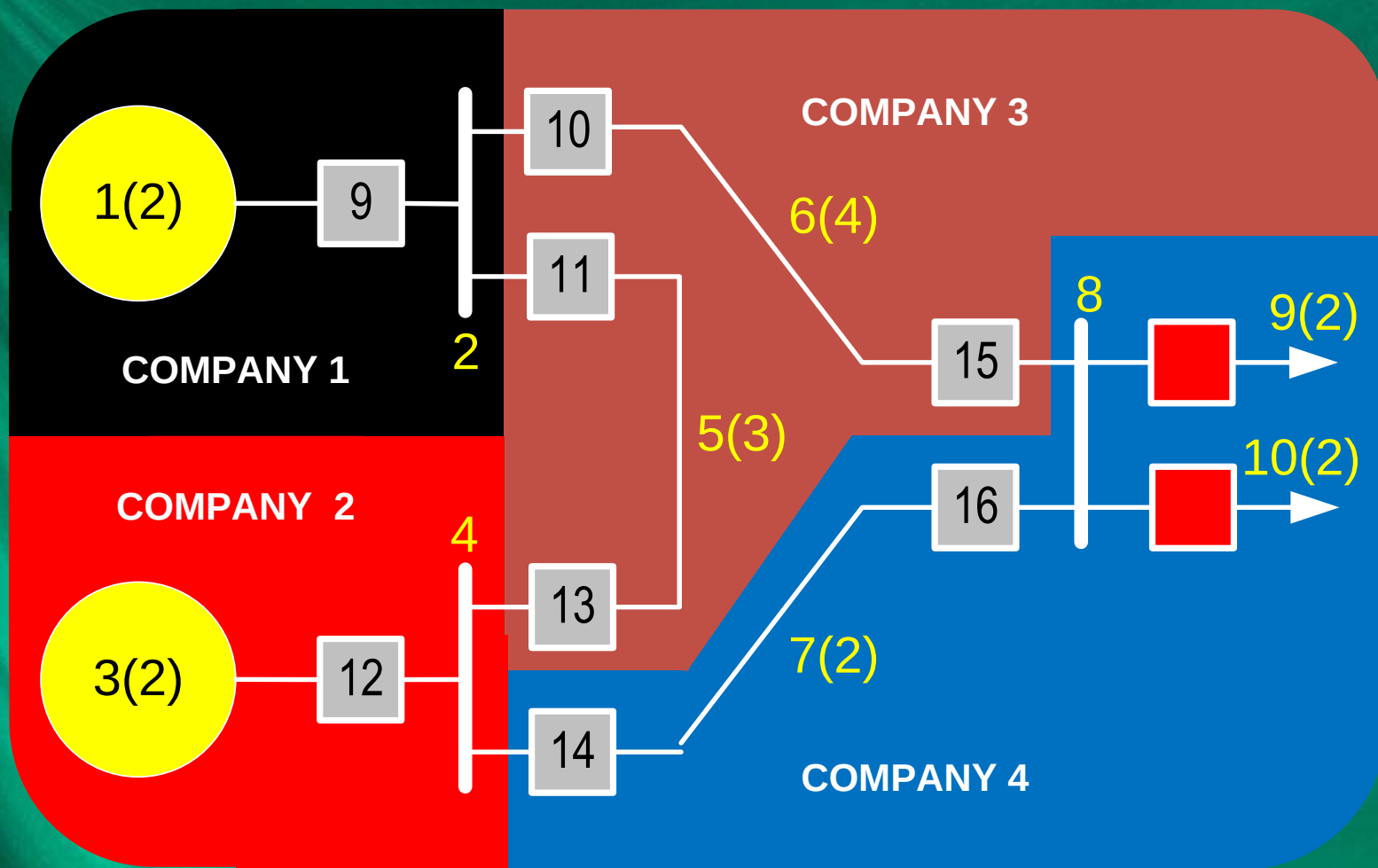


Protection Function



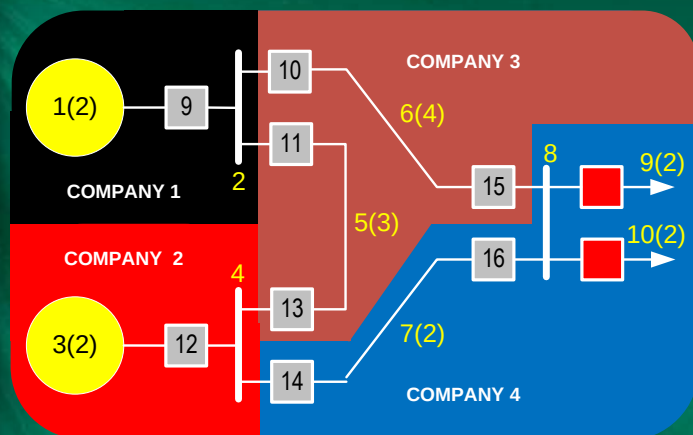
Power System Model

Sochi - 2015



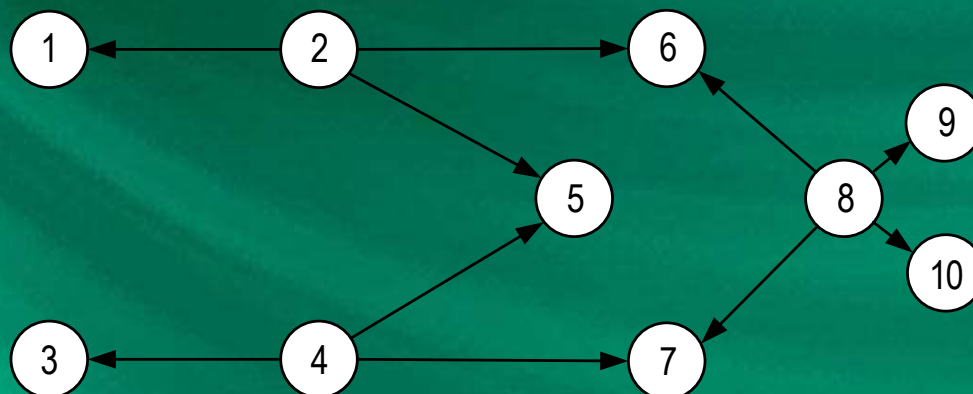
Adjacency for Planned Outages

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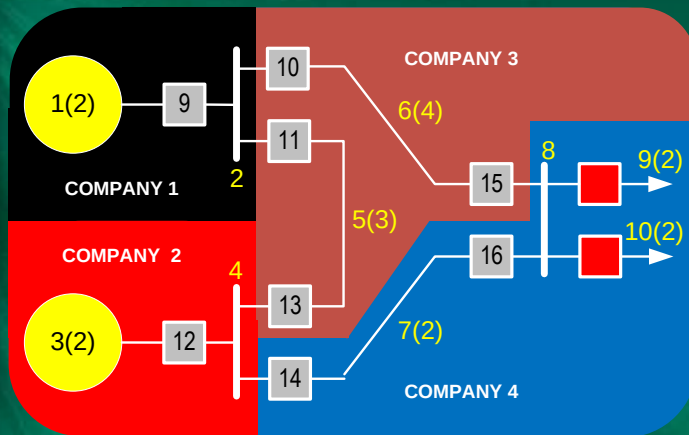
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5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
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Planned Adjacency

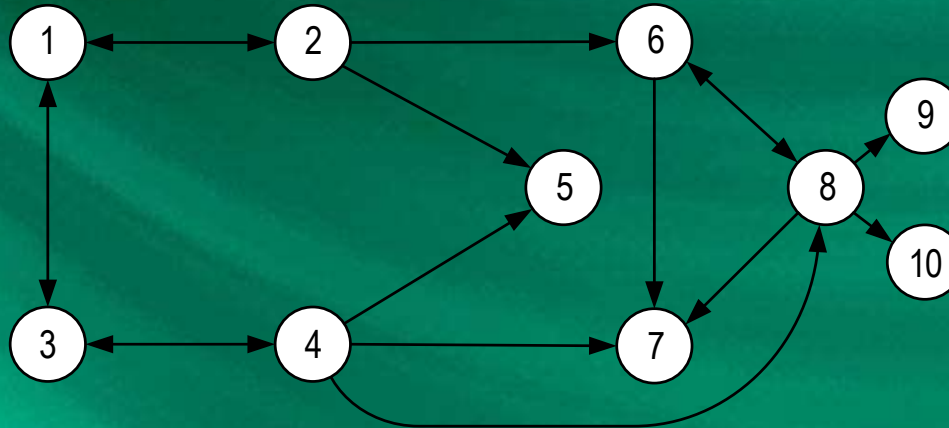


Adjacency for Forced Outages

Sochi - 2015

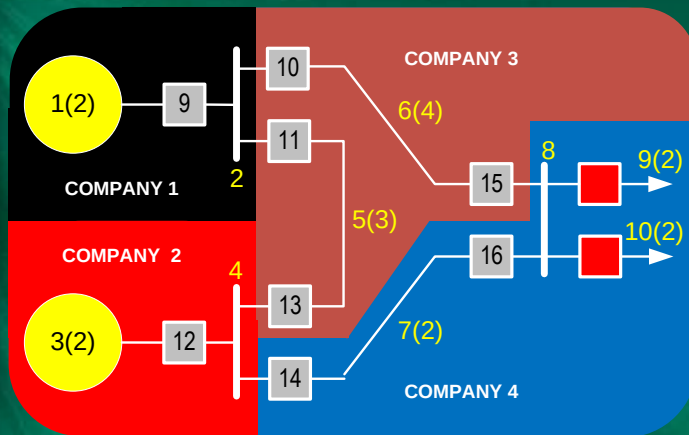
[illegible]

Forced Adjacency



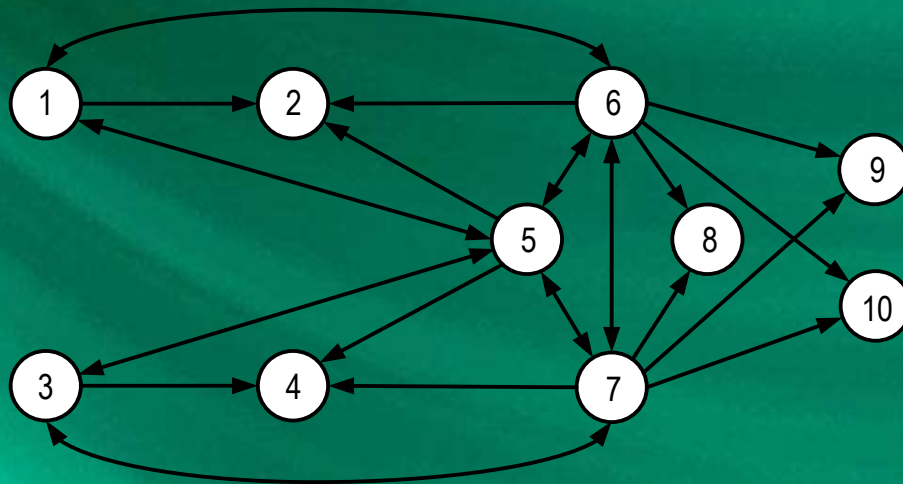
Vulnerability for Protection Systems

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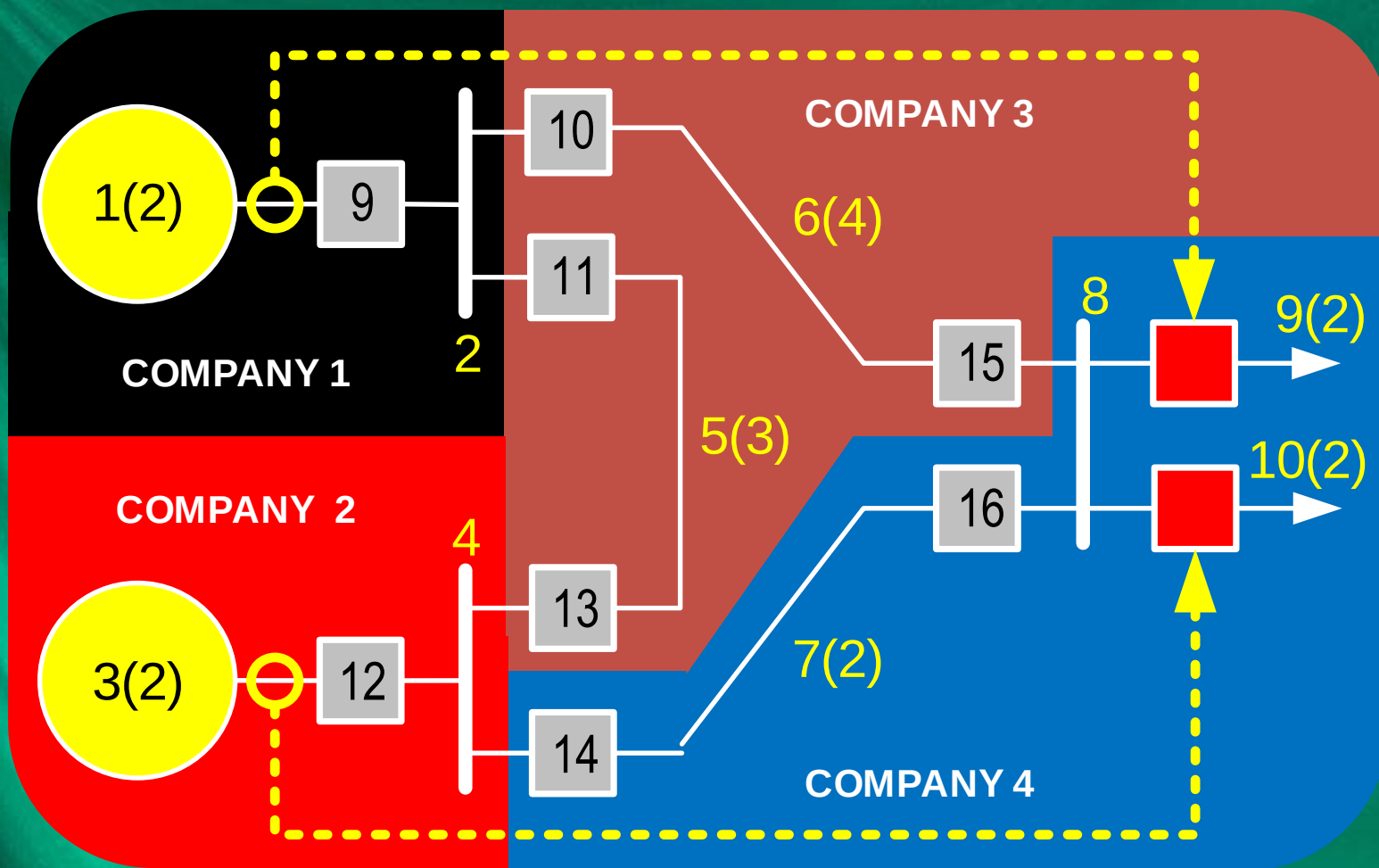
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4	0	0	0	0	0	0	0	0	0	0
5	1	1	1	1	0	0	0	0	0	0
6	1	1	0	0	1	0	1	1	1	1
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8	0	0	0	0	0	0	0	0	0	0
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Protection Vulnerability



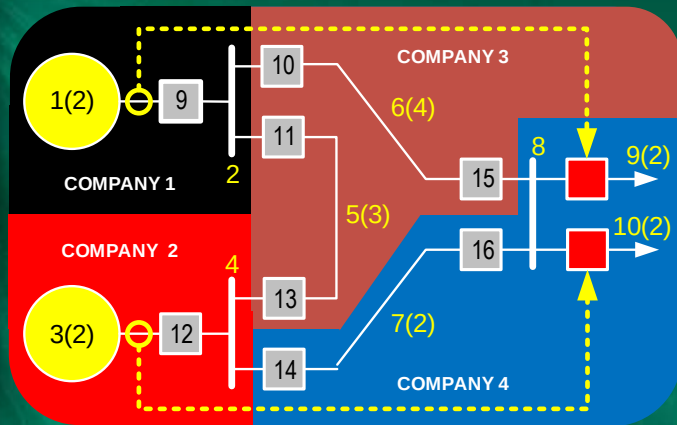
Wide-Area Protection System (WAPS)

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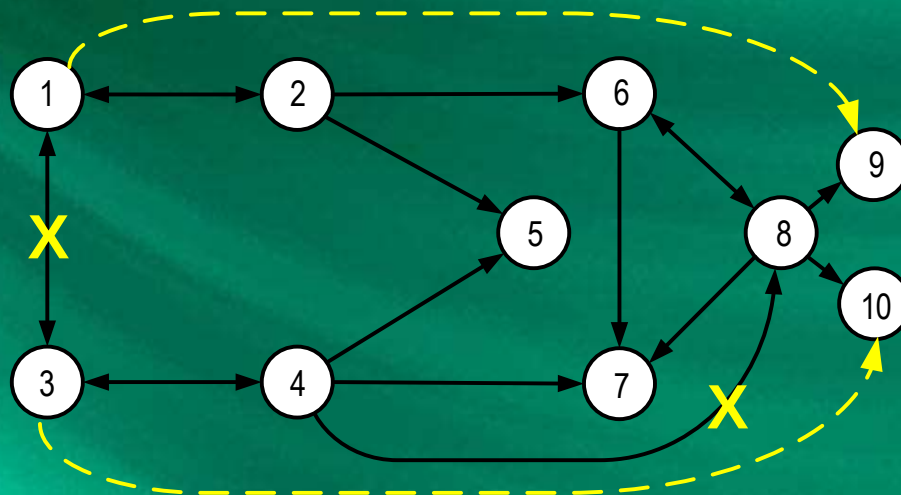
Forced Adjacency with Wide-Area Protection

Sochi - 2015



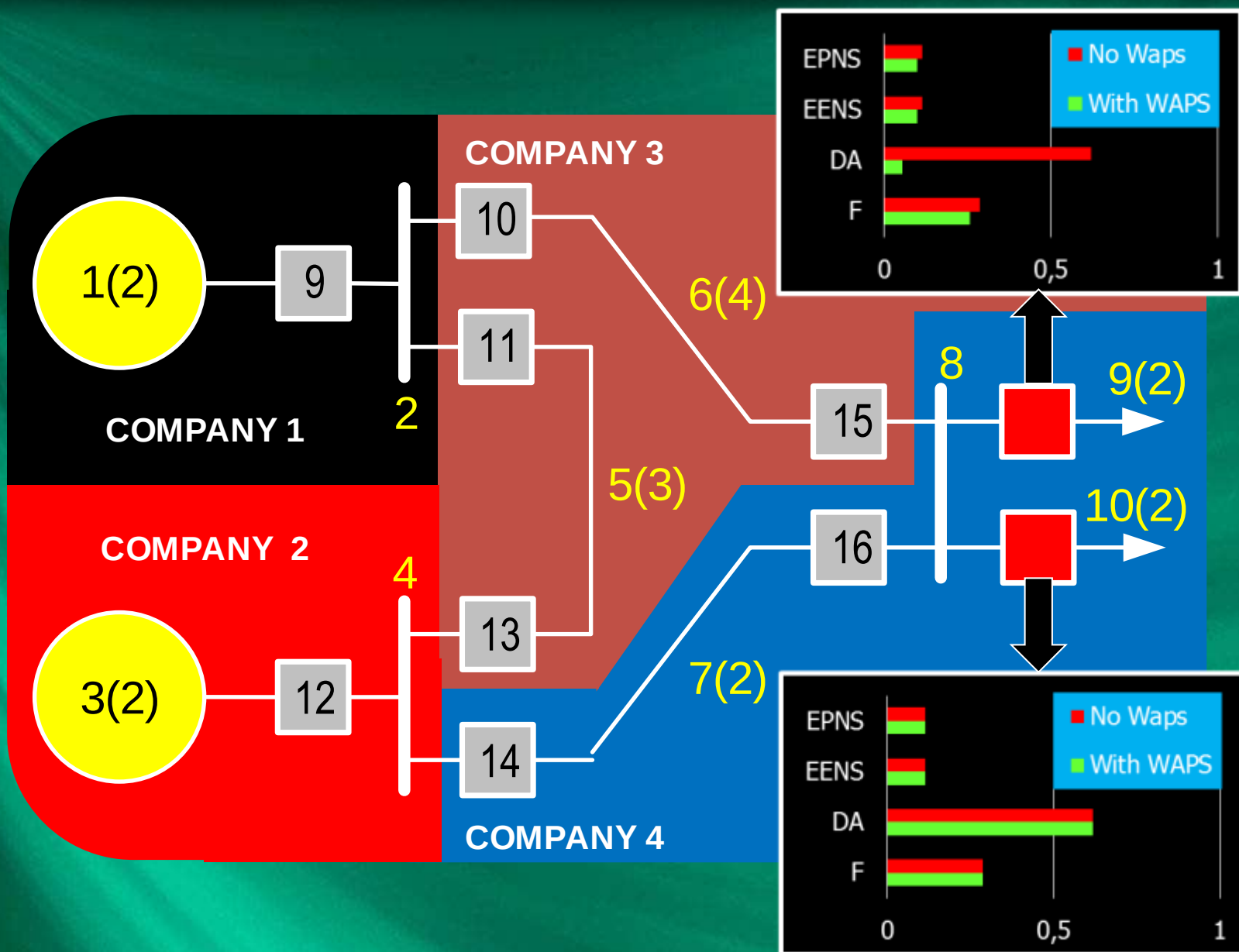
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4	0	0	1	0	1	0	1	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	1	1	0	1	1
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0

Forced Adjacency with WAPS



Impact of WAPS on Power System Performance

Sochi - 2015



Conclusions

- Graphical representation of disturbances
- Modeling of planned and forced outages
- Inclusion of protection failures
- Remote trips and load/generation shedding
- Implementation by matrix algebra
- Simultaneous estimation of multiple indexes
 - SAIFI, SAIDI, LOLP, LOLE, EENS, EDNS, etc...

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