



# Distribution Mode in RTDS Simulator

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# Outline

- Introduction
- Background
- Motivation
- Distribution Mode Simulation
- Future Development
- Questions and Answers





# Introduction

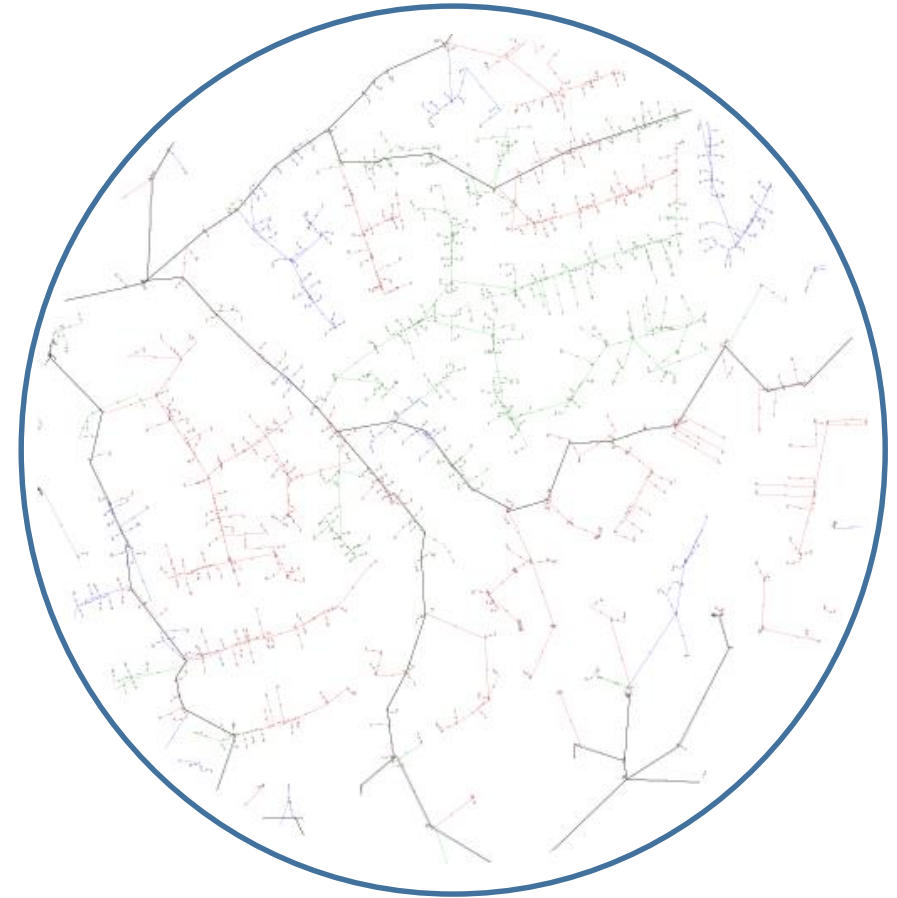


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# Introduction

Utilities have expressed interest in using RTDS to represent Distribution Systems

- Study new protection and automation devices, many of which now include communication and more complex setup procedures
- Study intelligent isolators and interrupters
- Impact of renewables on feeder operation
- Impact of energy storage components on feeder operation
- Integration with microgrids
- Cybersecurity





# Background

- Major Transmission System
- Distribution System

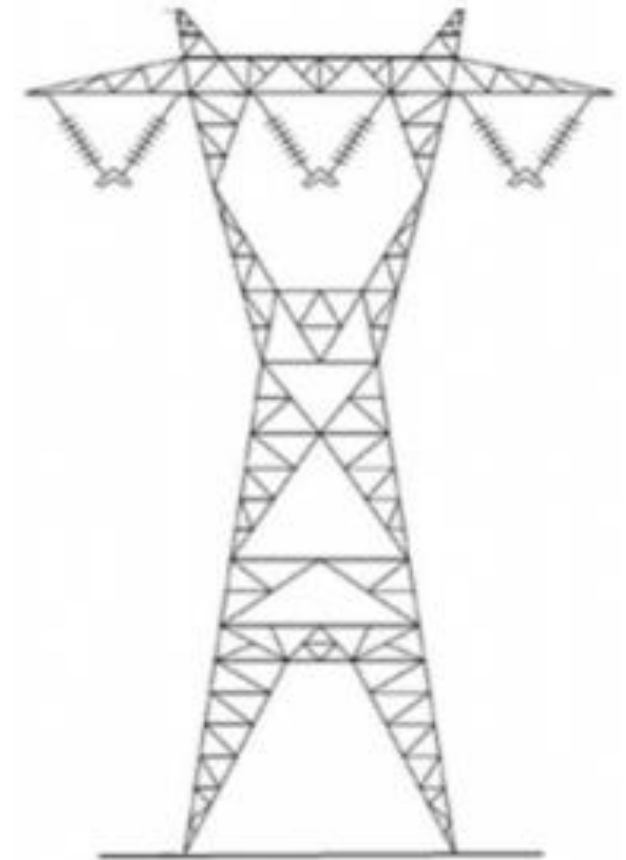


# Background

## Major Transmission System Characteristics

Distribution System structure is different from **major transmission**

- **Major transmission** systems have transmission lines long enough to permit splitting the network into multiple subsystems and using multiple RTDS Chassis to model the Power System.
- **Major transmission** systems have a meshed structure
- Studies involving **major transmission** often require detailed representation of components comprising the system. eg. generators (and their controls), HVDC/MMC (and their controls)

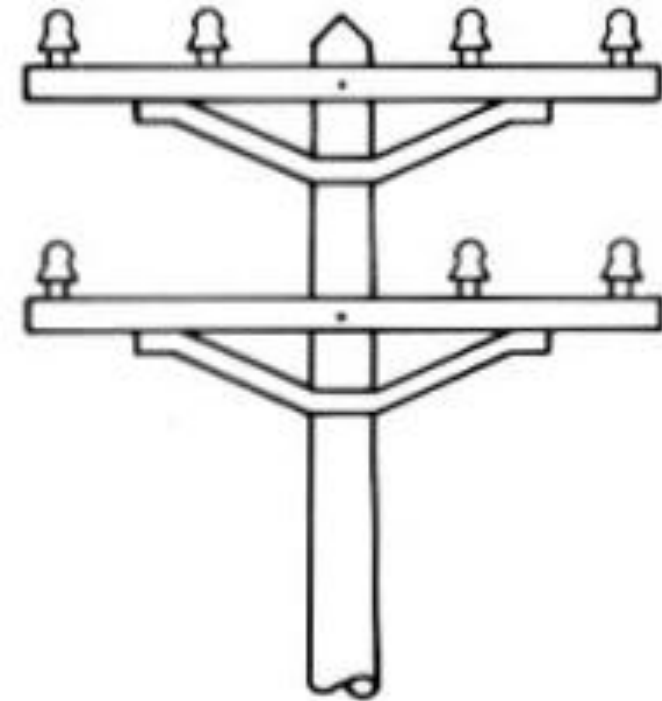


# Background

## Distribution System Characteristics

**Distribution** System structure is different from major transmission

- **Distribution** Systems rarely have transmission lines long enough to permit splitting the network into multiple subsystems.
- **Distribution** systems have a radial structure
- Studies involving **distribution** systems can use a more simplified representation of the system. For example
  - a. the source side can be represented using a system equivalent
  - b. distributed generation components can be represented using average models





# Motivation

- Limitations
- Solution





# Motivation

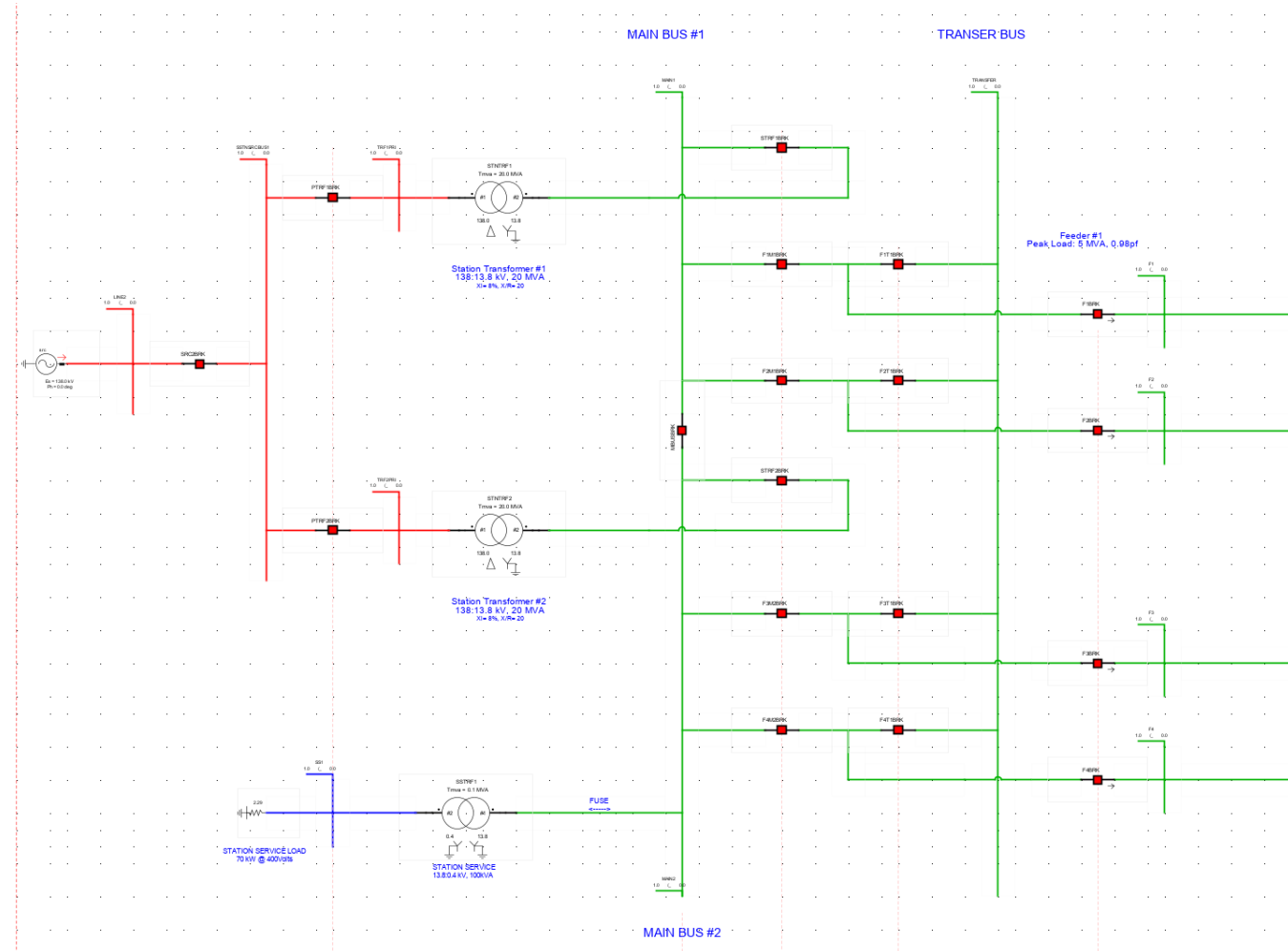
## Limitations

- Distribution systems often have a large number of nodes
- The absence of transmission lines long enough to split the network into subsystems
- Attempting to split the network into multiple subsystems by artificially specifying a longer line segment length or using a subsystem splitting transformer
- Attempting to compensate the additional capacitance by adding artificial shunt inductance changes the dynamic nature of the distribution system

# Motivation

## Feeders in Distribution Systems

- Distribution systems are typically comprised of multiple radial feeders emanating from a common bus fed from transmission level source.
- Feeder can be represented using a source behind an impedance
- The figure here shows a typical arrangement of a distribution level substation



# Motivation

## Distribution System Studies

- Distribution systems can be done using the existing capabilities of the RTDS
  - a. A feeder representation that falls within the node limitations of a NovaCor chassis
  - b. Require the detailed power electronic circuit modeling (small dt or sub-step feature)
- Distribution systems studies that:
  - a. Require more nodes than are available using a single NovaCor chassis
  - b. And do not require detailed power electronic circuits
  - c. Use **Distribution Mode Simulation** on the NovaCor



# Distribution Mode Simulation

- Distribution Mode Feature
- IEEE 34 Bus System in Distribution Mode
- CYME IMPORT Function



# Distribution Mode Simulation

## Distribution Mode Feature

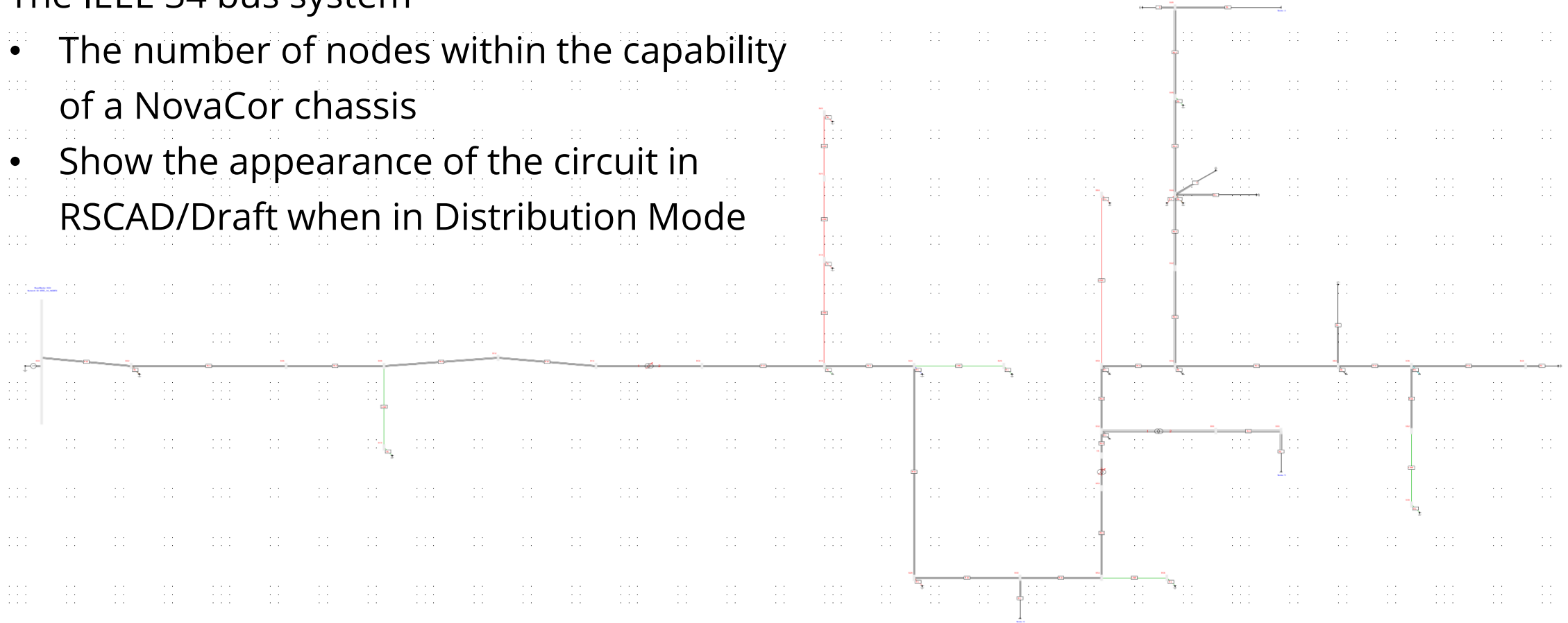
- Capabilities and limitations of Distribution Mode
  - a. Up to 1200 fully connected nodes using a single NovaCor chassis.
  - b. Special component library that includes typical distribution components optimized for distribution feeder layouts and that uses less processing resources.
  - c. Simulation time-step typically in the range of 150 usec
  - d. Average models used to represent renewables and distributed generation components.
  - e. Existing Control and Protection components can be used in distribution mode

# Distribution Mode Simulation

## IEEE 34 Bus System in Distribution Mode

The IEEE 34 bus system

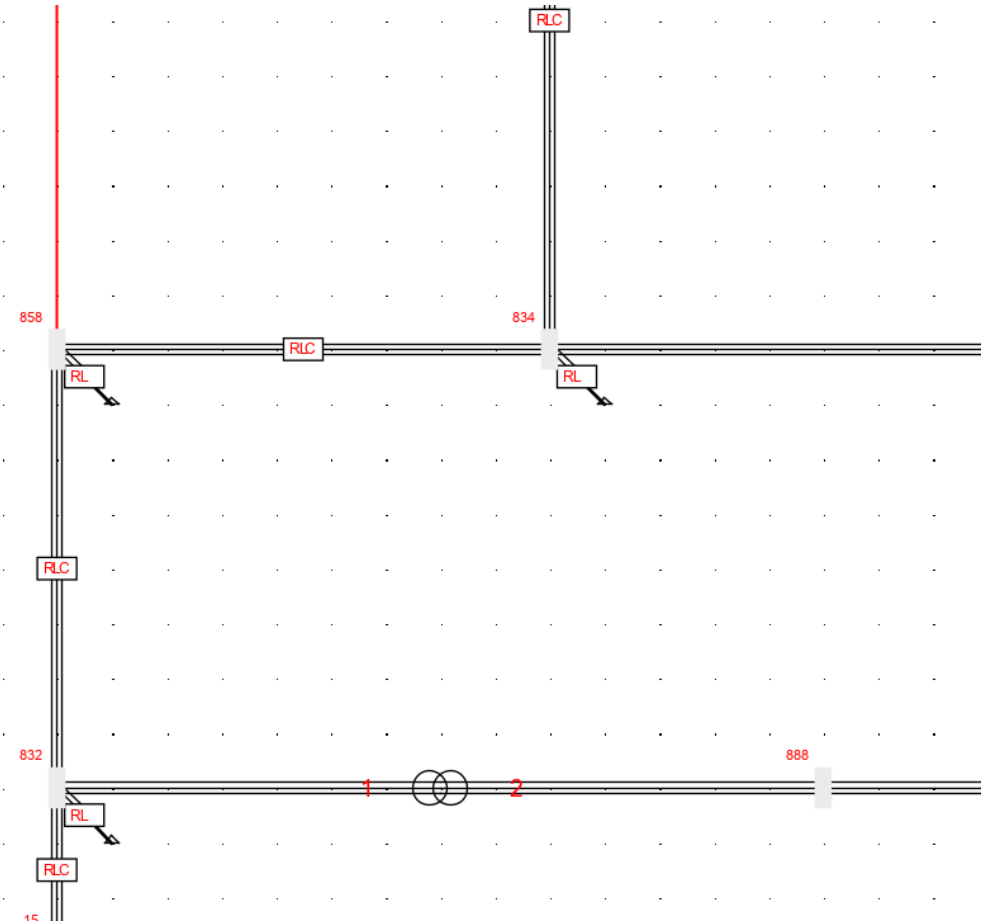
- The number of nodes within the capability of a NovaCor chassis
- Show the appearance of the circuit in RSCAD/Draft when in Distribution Mode



# Distribution Mode Simulation

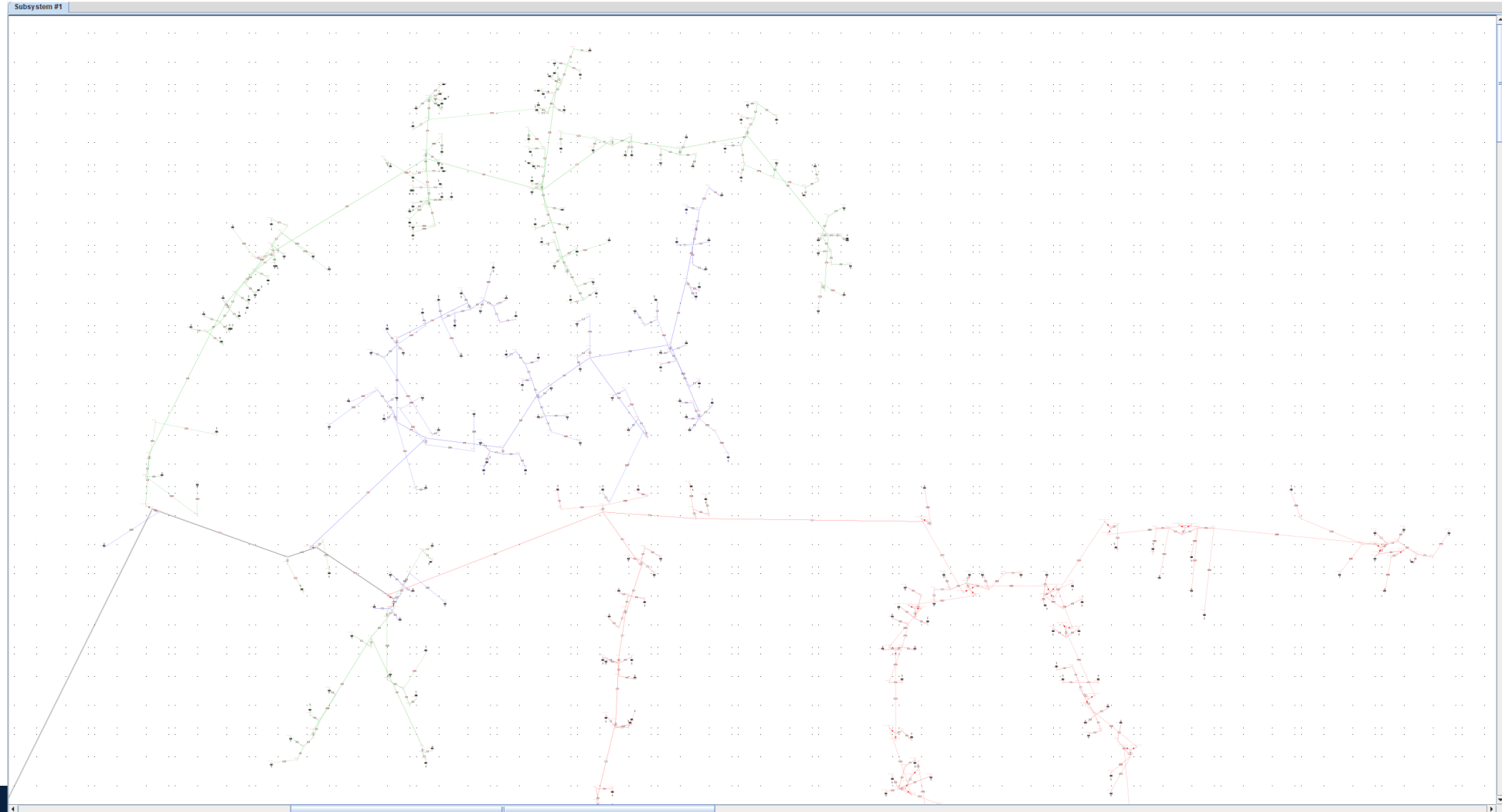
## IEEE 34 Bus System in Distribution Mode

- Distribution mode components include:
  - a. nodes, buses, stretchable branches and shunts.
  - b. The phase components (ABC, A, AB ... ) for each bus and branch can be specified
  - c. Loads can be represented as shunt passive branches or as constant Power type loads
  - d. Various induction machines including detailed single phase machine models



# Distribution Mode Simulation

## Larger Network in Distribution Mode





# Distribution Mode Simulation

## CYME IMPORT Function

- It will require a substantial effort to layout and enter the data in RSCAD/Draft for large distribution feeders
- Most utilities already have software to model the distribution feeder for offline studies (load flow, motor starting, capacitor optimization)
- An IMPORT program was developed in RSCAD
  - a. Read exported distribution system files from the CYME (cymdist) software
  - b. Import them into RTDS for use with distribution mode

# Distribution Mode Simulation

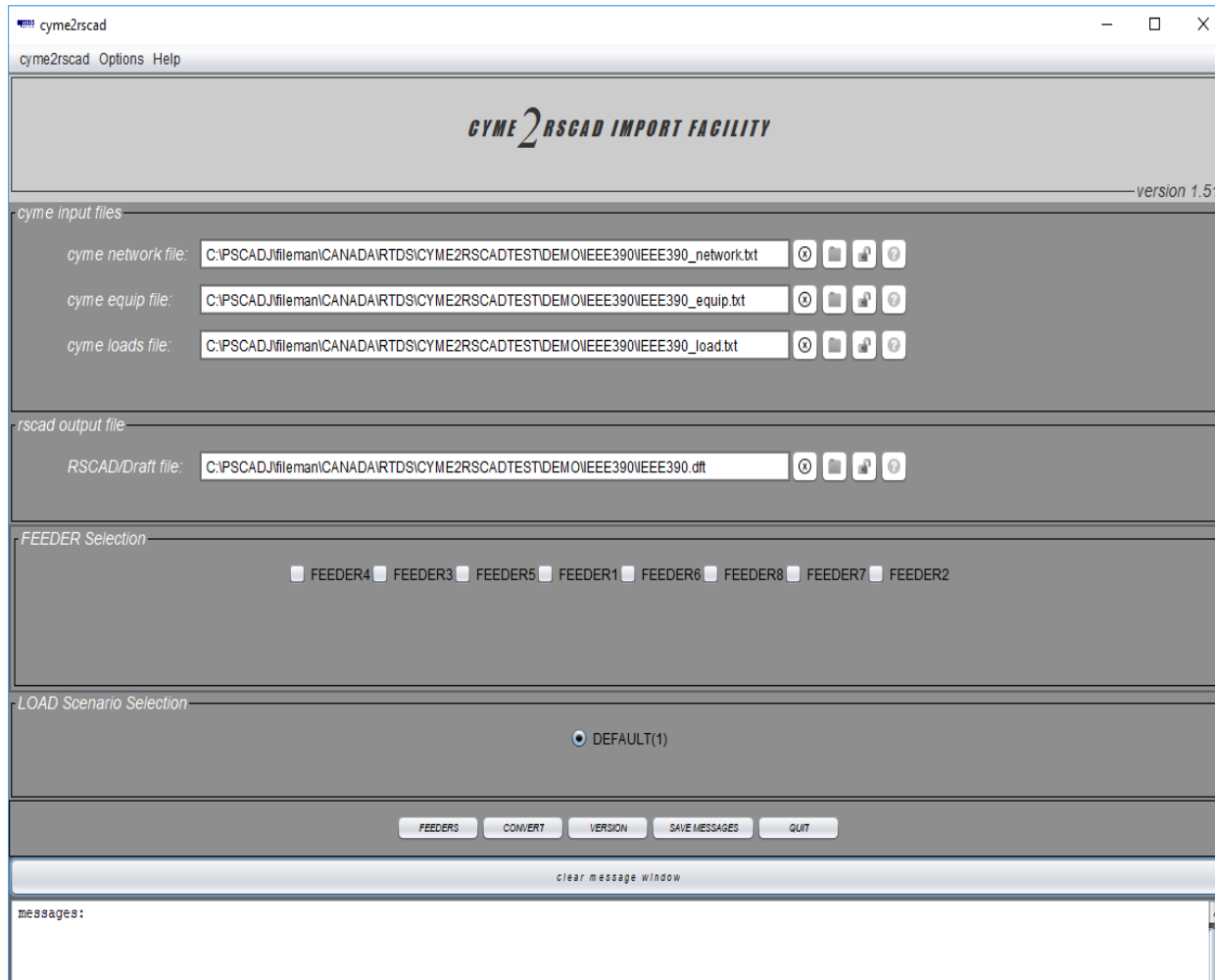
## CYME IMPORT Feature

An IMPORT from CYME was developed because:

- a. Some existing RTDS Users requested it
- b. The CYME software provides an EXPORT feature in which the case data (including component location data) is stored in simple text files
- c. The CYME component model data is similar to that required for the RTDS components
- d. CYME was in favour of the development of the IMPORT feature and provided documentation and support

# Distribution Mode Simulation

## CYME IMPORT GUI



- The CYME IMPORT GUI permits the user to specify the files to convert and which feeders are to be included as part of the conversion.
- An RSCAD/Draft case is available to compile and run using the RTDS.
- The IMPORT permits the user to eliminate components (eg. Fuses), combine series branches and eliminate lines/cables whose length is below a user defined threshold.



# Future Development



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# Future Development

- Distribution mode and the CYME Import facility are available with the current shipping version of RSCAD
- Development of the Distribution mode and CYME Import will continue based on customer requirements and feedback
- Utilities use various software packages to represent their distribution systems. Whether or not RTDS is able to develop IMPORT facilities for other formats depends on customer requests and whether such an IMPORT is supported by the 3rd party software vendor.

**Thank you!**

**Questions?**



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