An Introduction to SECS/GEM

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SECS/GEM

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Why SEMI Built a Universal Tongue

Standardization needed

In the 1980s, semiconductor manufacturing faced significant challenges due to proprietary communication protocols used by different equipment manufacturers. This led to interoperability issues and complex integration processes, making it difficult to achieve seamless communication between devices and factory systems.

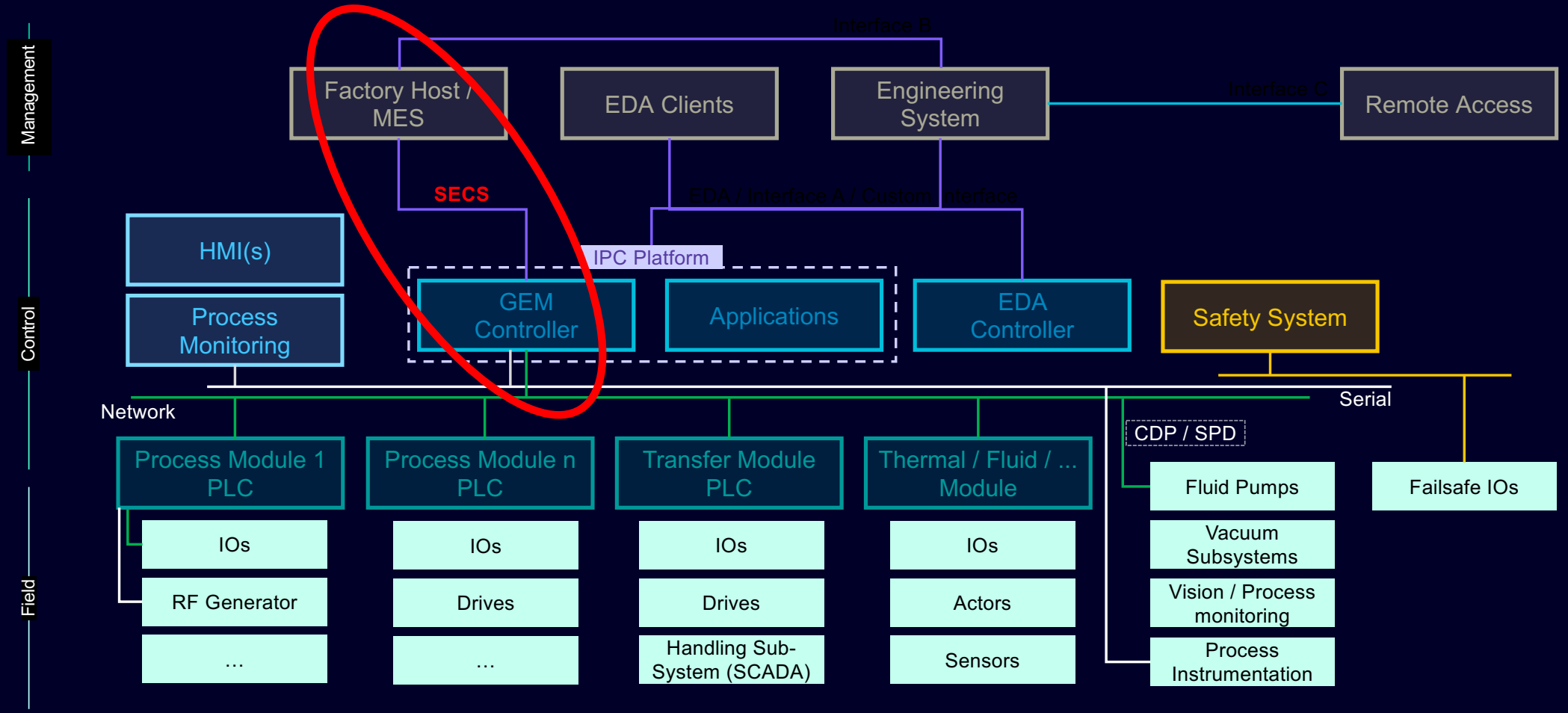
SEMI's Solution

To address these challenges, SEMI, the global semiconductor manufacturing industry association, initiated the development of a universal communication standard. This standard aimed to provide a common language for equipment and factory systems, facilitating smoother integration and automation.

Impact on Industry

The creation of SECS/GEM revolutionized the industry by enabling standardized communication between devices and factory systems. It reduced integration time, improved yield, and laid the foundation for modern automated manufacturing processes in semiconductor, SMT, PV, and other industries.

Typical FAB Communication Structure



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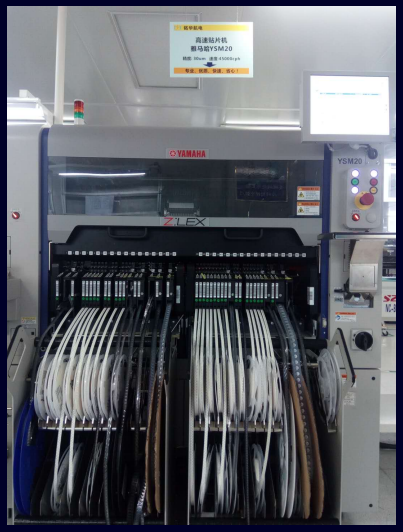
Why SEMI Built a Universal Tongue



SMT Machine

SECS/GEM CPU Unit

PC sends command to machine via SECS

PC receives data/events/alarms from machine via SECS

PC

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SEMI Standards Overview

Relevant SEMI standards

SECS/GEM is composed of several key SEMI standards: **E37 (HSMS)** for TCP/IP transport, **E5 (SECS-II)** for message grammar, **E30 (GEM)** for behavior rules, and **E4 (SECS-I)** for legacy serial communication. Each standard plays a crucial role in defining how equipment communicates with factory systems.

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SEMI Standards Overview

SEMI Standard	8 inch	12 inch	Function
E5	√	√	SECS-II
E30	√	√	GEM
E37	√	√	HSMS
E40		√	Process Job Management
E94		√	Control Job Management
E87		√	Carrier Management
E90		√	Substrate Tracking
……		√	

HSMS(E37)

HSMS Overview

HSMS, defined by SEMI E37, is a TCP/IP-based protocol that replaced the older serial SECS-I. It provides high-speed communication between equipment and factory systems, ensuring efficient data transfer.

Connection Management

The Select.Request and Select.Response mechanism in HSMS ensures reliable connections between equipment and factory systems. This handshake process is critical for establishing and maintaining communication links.

Key Timers

HSMS includes several key timers such as T3, T5, T6, T7, and T8. These timers manage communication delays and ensure that messages are sent and received within acceptable time frames, maintaining system responsiveness.

Network Considerations

Understanding HSMS is essential for configuring firewalls, VLANs, and VPNs in manufacturing environments. Proper setup ensures that equipment can communicate seamlessly with factory systems despite network complexities.

SECS-II(E5)

Encoding

Fill in the business data into List Item according to the E5 template, and then convert it to binary

Sending

Insert the Stream/Function into the HSMS header, and the Payload will be the just-encoded Item stream

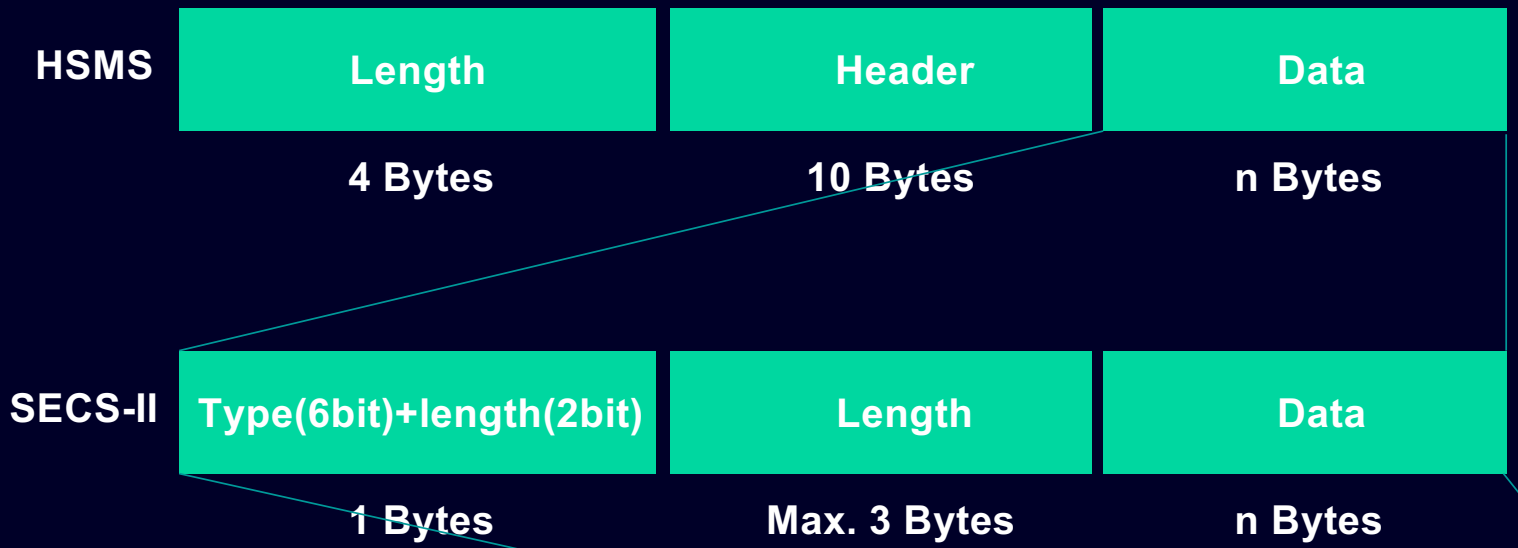
Decoding

After receiving the message, first unpack it according to the Item syntax, and then map it to the business object

Answering

Odd functions must return even functions. When W-Bit=1 times out, a retry or an error must be reported

Packet Format



1	Upper session ID
2	Lower session ID
3	Header bytes 2
4	Header bytes 3
5	PType
6	SType
7	System Bytes
8	System Bytes
9	System Bytes
10	System Bytes

E5 Data Format = Stream + Function + Dict Data

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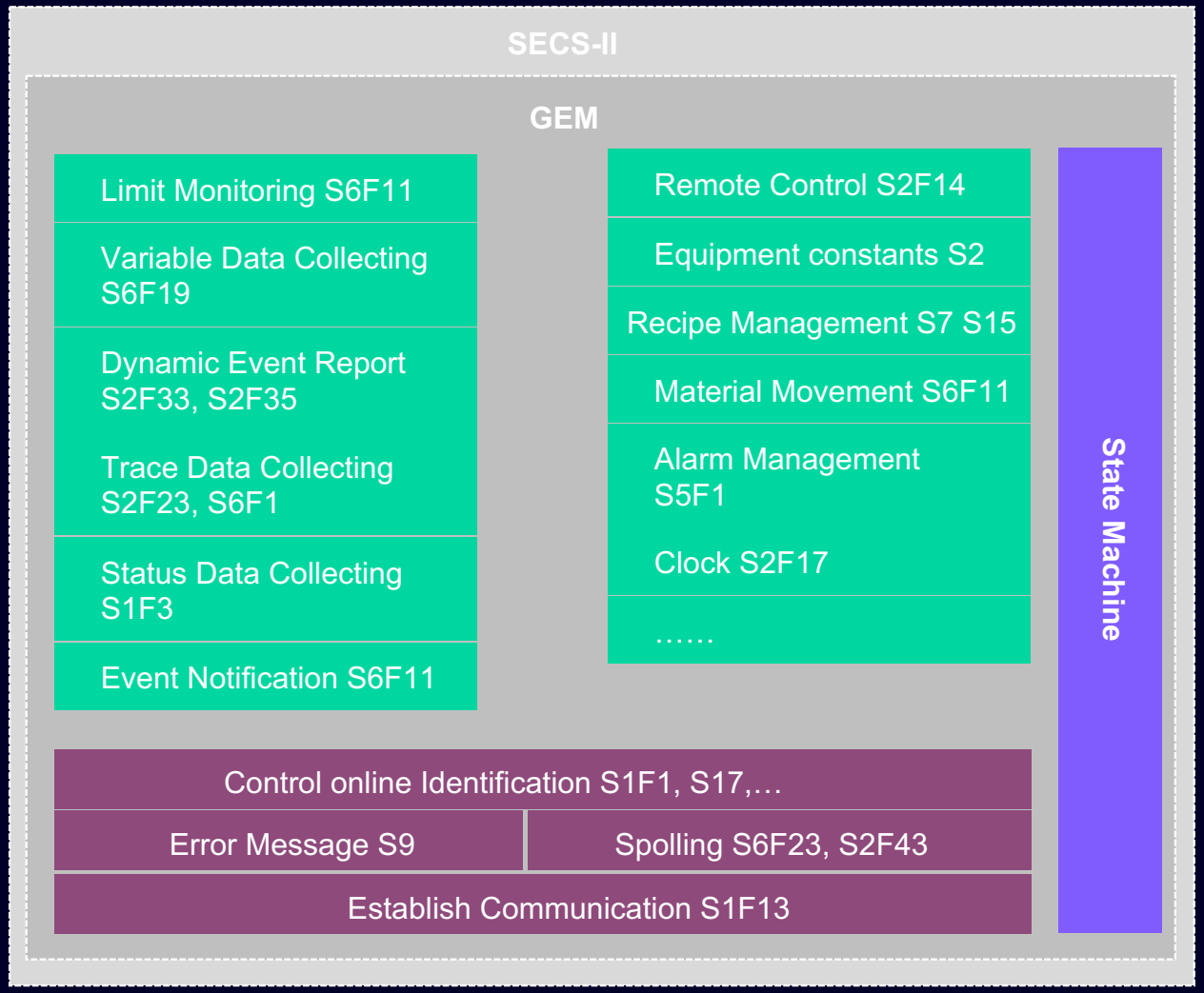
GEM(E30)



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Open Source Implementation

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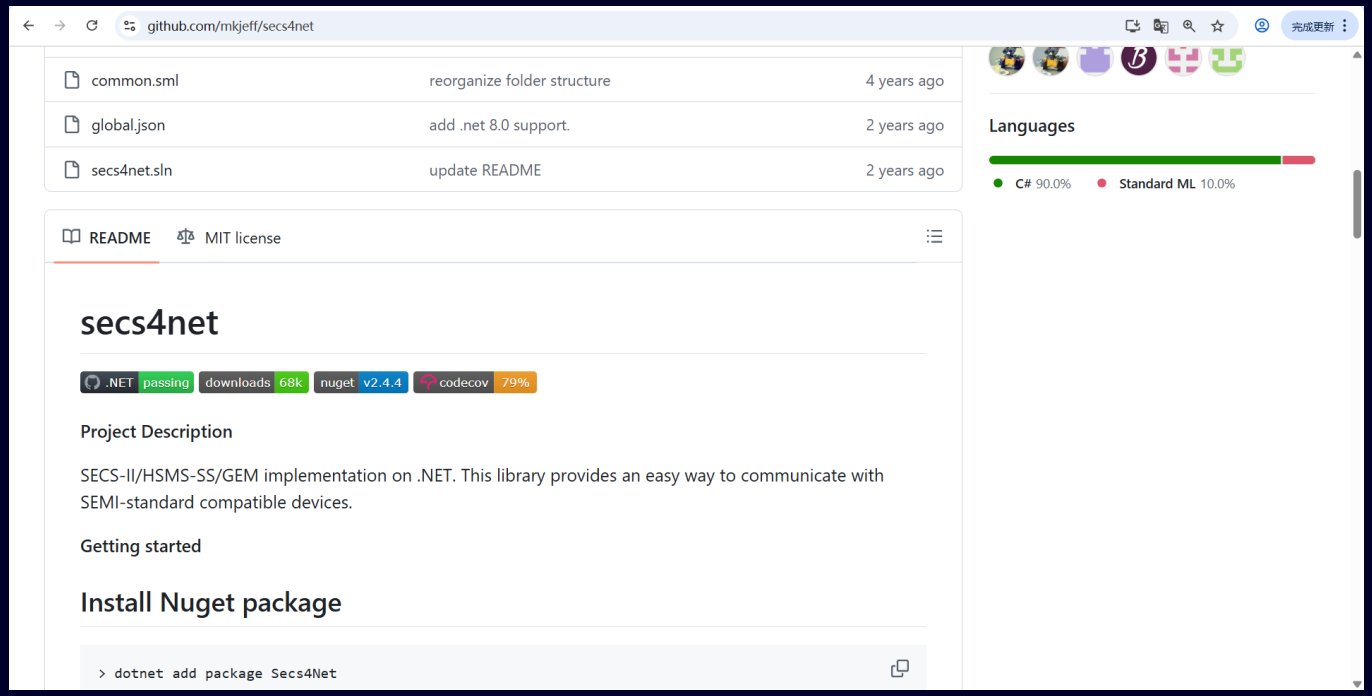
secs4net

secs4net is a LGPL 2.1 licensed .NET implementation of SECS-II/HSMS-SS/GEM.

Pro
To our knowledge this is the most complete Open Source implementation. Actual documented usage in the field.

Con
.NET doesn't fit well into our Edge Stack.



https://github.com/mkjeff/secs4net

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secsgem

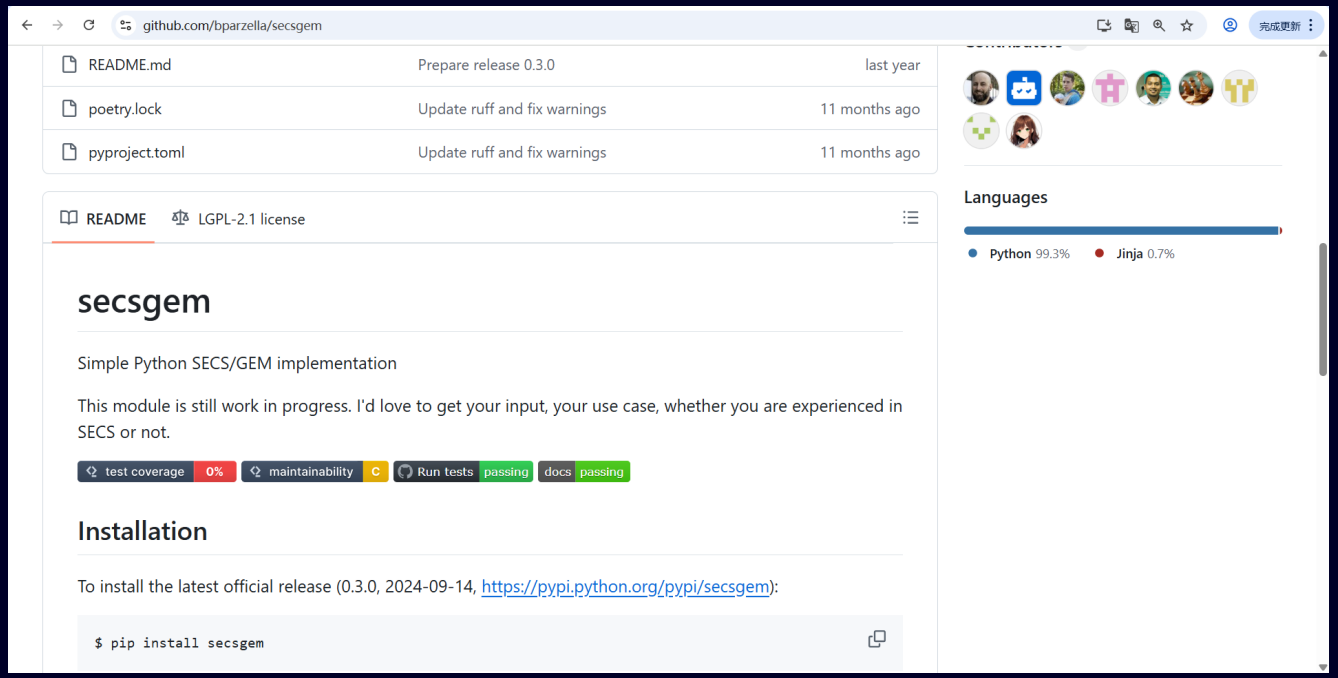
secsgem is a MIT licensed Python library that offers native asyncio support for SECS/GEM.

Pro

Far easier to use on our Edge stack, though still not optimal implementation for us.

Con

More or less single maintainer.
Not feature complete



https://github.com/bparzella/secsgem

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No FAB, no Problem

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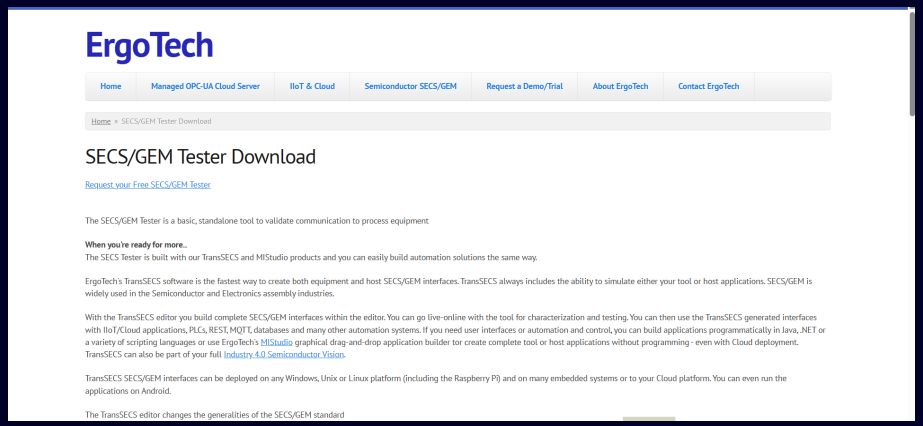
Interaction without real machines

Certifications

SEMI certification involves rigorous testing of timing, recovery, and edge cases. This ensures that SECS/GEM implementations meet industry standards for reliability and performance.

Simulation tooling

Free test tools are available. These tools help developers simulate various scenarios and identify potential issues before submitting their implementations for certification.



https://ergotech.com/secstesterdownload

https://gitcode.com/Universal-Tool/3181f

https://www.einnosys.com/eigemsim/

https://gitcode.com/open-source-toolkit/d4343

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Old, yet still evolving

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GEM3000 and beyond

GEM300

As manufacturing processes become more complex, GEM300 standards are essential for carrier ID, substrate tracking, and recipe approval. These enhancements support advanced automation and data management in modern fabs.

Looking ahead

SECS/GEM is evolving to integrate with communication technologies like OPC-UA and MQTT. This integration will enable more efficient data exchange and control, supporting the next generation of smart manufacturing.

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Summary

Protocol Availability
Evaluation of niche protocols is easier than ever with open available implementations.
We prefer running code over extensive documentation.

Check your “supplier”
Rating the quality of a project is a non-trivial task. Good starting points are: repository activities, error reports, source of commits (individual contributor vs. professional).
SCES/GEM papers should be .

Mature simulation eco-system
If you like to look behind the scene of a fab but you can’t afford the actual machines, you can abuse the simulation tooling traditionally used for certification processes.

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Thanks and any questions?

You probably will never use SECS/GEM directly.
But your tape-out is only possible because of it.

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