CybOX Version 2.1.1 Part 77: Win Memory Page Region Object

Working Draft 01

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Technical Committee:

[OASIS Cyber Threat Intelligence (CTI) TC](https://www.oasis-open.org/committees/cti)

Chair:

Richard Struse ([Richard.Struse@HQ.DHS.GOV](mailto:Richard.Struse@HQ.DHS.GOV)), [DHS Office of Cybersecurity and Communications (CS&C)](http://www.dhs.gov/office-cybersecurity-and-communications)

Editors:

Desiree Beck ([dbeck@mitre.org](mailto:ikirillov@mitre.org)), [MITRE Corporation](http://www.mitre.org/)

Trey Darley ([trey@soltra.com](mailto:trey@soltra.com)), [Soltra](http://www.soltra.com/)

Ivan Kirillov ([ikirillov@mitre.org](mailto:ikirillov@mitre.org)), [MITRE Corporation](http://www.mitre.org/)

Rich Piazza ([rpiazza@mitre.org](mailto:ikirillov@mitre.org)), [MITRE Corporation](http://www.mitre.org/)

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*CybOX Version 2.1.1 Part 1: Overview*. [URI]

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*CybOX Version 2.1.1 Part 19: Device Object*. [URI]

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*CybOX Version 2.1.1 Part 21: Disk Partition Object*. [URI]

*CybOX Version 2.1.1 Part 22: Domain Name Object*. [URI]

*CybOX Version 2.1.1 Part 23: Email Message Object*. [URI]

*CybOX Version 2.1.1 Part 24: File Object*. [URI]

*CybOX Version 2.1.1 Part 25: GUI Dialogbox Object*. [URI]

*CybOX Version 2.1.1 Part 26: GUI Object*. [URI]

*CybOX Version 2.1.1 Part 27: GUI Window Object*. [URI]

*CybOX Version 2.1.1 Part 28: HTTP Session Object*. [URI]

*CybOX Version 2.1.1 Part 29: Hostname Session Object*. [URI]

*CybOX Version 2.1.1 Part 30: Image File Object*. [URI]

*CybOX Version 2.1.1 Part 31: Library File Object*. [URI]

*CybOX Version 2.1.1 Part 32: Link Object*. [URI]

*CybOX Version 2.1.1 Part 33: Linux Package Object*. [URI]

*CybOX Version 2.1.1 Part 34: Memory Object*. [URI]

*CybOX Version 2.1.1 Part 35: Mutex Object*. [URI]

*CybOX Version 2.1.1 Part 36: Network Connection Object*. [URI]

*CybOX Version 2.1.1 Part 37: Network Flow Object*. [URI]

*CybOX Version 2.1.1 Part 38: Network Packet Object*. [URI]

*CybOX Version 2.1.1 Part 39: Network Route Entry Object*. [URI]

*CybOX Version 2.1.1 Part 40: Network Route Object*. [URI]

*CybOX Version 2.1.1 Part 41: Network Socket Object*. [URI]

*CybOX Version 2.1.1 Part 42: Network Subnet Object*. [URI]

*CybOX Version 2.1.1 Part 43: PDF File Object*. [URI]

*CybOX Version 2.1.1 Part 44: Pipe Object*. [URI]

*CybOX Version 2.1.1 Part 45: Port Object*. [URI]

*CybOX Version 2.1.1 Part 46: Process Object*. [URI]

*CybOX Version 2.1.1 Part 47: Product Object*. [URI]

*CybOX Version 2.1.1 Part 48: SMS Message Object*. [URI]

*CybOX Version 2.1.1 Part 49: Semaphore Object*. [URI]

*CybOX Version 2.1.1 Part 50: Socket Address Object*. [URI]

*CybOX Version 2.1.1 Part 51: System Object*. [URI]

*CybOX Version 2.1.1 Part 52: URI Object*. [URI]

*CybOX Version 2.1.1 Part 53: URL History Object*. [URI]

*CybOX Version 2.1.1 Part 54: Unix File Object*. [URI]

*CybOX Version 2.1.1 Part 55: Unix Network Route Entry Object*. [URI]

*CybOX Version 2.1.1 Part 56: Unix Pipe Object*. [URI]

*CybOX Version 2.1.1 Part 57: Unix Process Object*. [URI]

*CybOX Version 2.1.1 Part 58: Unix User Account Object*. [URI]

*CybOX Version 2.1.1 Part 59: Unix Volume Object*. [URI]

*CybOX Version 2.1.1 Part 60: Unix Account Object*. [URI]

*CybOX Version 2.1.1 Part 61: User Session Object*. [URI]

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*CybOX Version 2.1.1 Part 63: Whois Object*. [URI]

*CybOX Version 2.1.1 Part 64: Win Computer Account Object*. [URI]

*CybOX Version 2.1.1 Part 65: Win Critical Section Object*. [URI]

*CybOX Version 2.1.1 Part 66: Win Driver Object*. [URI]

*CybOX Version 2.1.1 Part 67: Win Event Log Object*. [URI]

*CybOX Version 2.1.1 Part 68: Win Event Object*. [URI]

*CybOX Version 2.1.1 Part 69: Win Executable File Object*. [URI]

*CybOX Version 2.1.1 Part 70: Win File Object*. [URI]

*CybOX Version 2.1.1 Part 71: Win Filemapping Object*. [URI]

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*CybOX Version 2.1.1 Part 73: Win Hook Object*. [URI]

*CybOX Version 2.1.1 Part 74: Win Kernel Hook Object*. [URI]

*CybOX Version 2.1.1 Part 75: Win Kernel Object*. [URI]

*CybOX Version 2.1.1 Part 76: Win Mailslot Object*. [URI]

*CybOX Version 2.1.1 Part 77: Win Memory Page Region Object*. [URI]

*CybOX Version 2.1.1 Part 78: Win Mutex Object*. [URI]

*CybOX Version 2.1.1 Part 79: Win Network Route Entry Object*. [URI]

*CybOX Version 2.1.1 Part 80: Win Network Share Object*. [URI]

*CybOX Version 2.1.1 Part 81: Win Pipe Object*. [URI]

*CybOX Version 2.1.1 Part 82: Win Prefetch Object*. [URI]

*CybOX Version 2.1.1 Part 83: Win Process Object*. [URI]

*CybOX Version 2.1.1 Part 84: Win Registry Key Object*. [URI]

*CybOX Version 2.1.1 Part 85: Win Semaphore Object*. [URI]

*CybOX Version 2.1.1 Part 86: Win Service Object*. [URI]

*CybOX Version 2.1.1 Part 87: Win System Object*. [URI]

*CybOX Version 2.1.1 Part 88: Win System Restore Object*. [URI]

*CybOX Version 2.1.1 Part 89: Win Task Object*. [URI]

*CybOX Version 2.1.1 Part 90: Win Thread Object*. [URI]

*CybOX Version 2.1.1 Part 91: Win User Account Object*. [URI]

*CybOX Version 2.1.1 Part 92: Win Volume Object*. [URI]

*CybOX Version 2.1.1 Part 93: Win Waitable Timer Object*. [URI]

*CybOX Version 2.1.1 Part 94: X509 Certificate Object*. [URI]

Related work:

This specification is related to:

*STIX Version 1.2.1 (placeholder)*

Abstract:

The Cyber Observable Expression (CybOX) is a standardized language for encoding and communicating high-fidelity information about cyber observables, whether dynamic events or stateful measures that are observable in the operational cyber domain. By specifying a common structured schematic mechanism for these cyber observables, the intent is to enable the potential for detailed automatable sharing, mapping, detection and analysis heuristics. This specification document defines the Win Memory Page Region Object data model, which is one of the Object data models for CybOX content.

Status:

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# Introduction

The Cyber Observable Expression (CybOX) provides a common structure for representing cyber observables across and among the operational areas of enterprise cyber security. CybOX improves the consistency, efficiency, and interoperability of deployed tools and processes, and it increases overall situational awareness by enabling the potential for detailed automatable sharing, mapping, detection, and analysis heuristics.

This document serves as the specification for the CybOX Win Memory Page Region Object Version 2.1.1 data model, which is one of ninety-four Object data models for CybOX content.

In Section **1.1** we discuss additional specification documents, in Section **1.2** we provide document conventions in, and in Section **1.3** we provide terminology. References are given in Sections **1.4** and **1.5**. In Section **2**, we give background information necessary to fully understand the Win Memory Page Region Object data model. We present the Win Memory Page Region Object data model specification details in Section **3** and conformance information in Section **4**.

## CybOX Specification Documents

The CybOX specification consists of a formal UML model and a set of textual specification documents that explain the UML model. Specification documents have been written for each of the key individual data models that compose the full CybOX UML model.

CybOX has a modular design comprising two fundamental data models and a collection of Object data models. The fundamental data models – CybOX Core and CybOX Common – provide essential CybOX structure and functionality. The CybOX Objects, defined in individual data models, are precise characterizations of particular types of observable cyber entities (e.g., HTTP session, Windows registry key, DNS query).

Use of the CybOX Core and Common data models is required; however, use of the CybOX Object data models is purely optional: users select and use only those Objects and corresponding data models that are needed. Importing the entire CybOX suite of data models is not necessary.

The [*CybOX Version 2.1.1 Part 1: Overview*](#AdditionalArtifacts) document provides a comprehensive overview of the full set of CybOX data models, which in addition to the Core, Common, and numerous Object data models, includes a set of default controlled vocabularies. [*CybOX Version 2.1.1 Part 1: Overview*](#AdditionalArtifacts) also summarizes the relationship of CybOX to other languages, and outlines general CybOX data model conventions.

## Document Conventions

The following conventions are used in this document.

### Fonts

The following font and font style conventions are used in the document:

* Capitalization is used for CybOX high level concepts, which are defined in [*CybOX Version 2.1.1 Part 1: Overview*](#AdditionalArtifacts).
  + Examples: Action, Object, Event, Property
* The Courier New font is used for writing UML objects.
  + Examples: ActionType, cyboxCommon:BaseObjectPropertyType
  + Note that all high level concepts have a corresponding UML object. For example, the Action high level concept is associated with a UML class named, ActionType.
* The ‘*italic’* font (withsingle quotes) is used for noting actual, explicit values for CybOX Language properties. The *italic* font (without quotes) is used for noting example values.
  + - Example:  *‘HashNameVocab-1.0,’ high, medium, low*

### UML Package References

Each CybOX data model is captured in a different UML package (e.g., Core package) where the packages together compose the full CybOX UML model. To refer to a particular class of a specific package, we use the format package\_prefix:class, where package\_prefix corresponds to the appropriate UML package. The [*CybOX Version 2.1.1 Part 1: Overview*](#AdditionalArtifacts) document contains the full list of CybOX packages, along with the associated prefix notations, descriptions, and examples.

Note that in this specification document, we do not explicitly specify the package prefix for any classes that originate from the Win Memory Page Region Object data model.

### UML Diagrams

This specification makes use of UML diagrams to visually depict relationships between CybOX Language constructs. Note that the diagrams have been extracted directly from the full UML model for CybOX; they have not been constructed purely for inclusion in the specification documents.  Typically, diagrams are included for the primary class of a data model, and for any other class where the visualization of its relationships between other classes would be useful.  This implies that there will be very few diagrams for classes whose only properties are either a data type or a class from the CybOX Common data model.  Other diagrams that are included correspond to classes that specialize a superclass and abstract or generalized classes that are extended by one or more subclasses.

In UML diagrams, classes are often presented with their attributes elided, to avoid clutter. The fully described class can usually be found in a related diagram. A class presented with an empty section at the bottom of the icon indicates that there are no attributes other than those that are visualized using associations.

#### Class Properties

Generally, a class property can be shown in a UML diagram as either an attribute or an association (i.e., the distinction between attributes and associations is somewhat subjective). In order to make the size of UML diagrams in the specifications manageable, we have chosen to capture most properties as attributes and to capture only higher level properties as associations, especially in the main top-level component diagrams. In particular, we will always capture properties of UML data types as attributes. For example, properties of a class that are identifiers, titles, and timestamps will be represented as attributes.

#### Diagram Icons and Arrow Types

Diagram icons are used in a UML diagram to indicate whether a shape is a class, enumeration, or a data type, and decorative icons are used to indicate whether an element is an attribute of a class or an enumeration literal. In addition, two different arrow styles indicate either a directed association relationship (regular arrowhead) or a generalization relationship (triangle-shaped arrowhead). The icons and arrow styles we use are shown and described in **Table 1‑1**

Table 1-1 needs to be c & p here

#### Color Coding

The shapes of the UML diagrams are color coded to indicate the data model associated with a class.  The colors used in the Win Memory Page Region Object specification are illustrated via exemplars in **Figure 1‑1**.

[need diagram]

Figure 1‑1. Data model color coding

### Property Table Notation

Throughout Section 3, tables are used to describe the properties of each data model class. Each property table consists of a column of names to identify the property, a type column to reflect the datatype of the property, a multiplicity column to reflect the allowed number of occurrences of the property, and a description column that describes the property. Package prefixes are provided for classes outside of the Win Memory Page Region Object data model (see Section 1.2.3).

Note that if a class is a specialization of a superclass, only the properties that constitute the specialization are shown in the property table (i.e., properties of the superclass will not be shown). However, details of the superclass may be shown in the UML diagram.

### Property and Class Descriptions

Each class and property defined in CybOX is described using the format, “The X property verbY.” For example, in the specification for the CybOX Core data model, we write, “The id property specifies a globally unique identifier for the Action.” In fact, the verb “specifies” could have been replaced by any number of alternatives: “defines,” “describes,” “contains,” “references,” etc.

However, we thought that using a wide variety of verb phrases might confuse a reader of a specification document because the meaning of each verb could be interpreted slightly differently. On the other hand, we didn’t want to use a single, generic verb, such as “describes,” because although the different verb choices may or may not be meaningful from an implementation standpoint, a distinction could be useful to those interested in the modeling aspect of CybOX.

Consequently, we have chosen to use the three verbs, defined as follows, in class and property descriptions:

|  |  |
| --- | --- |
| **Verb** | **CybOX Definition** |
| captures | Used to record and preserve information without implying anything about the structure of a class or property. Often used for properties that encompass general content. This is the least precise of the three verbs. |
|  | *Examples*:  The Observable\_Source property characterizes the source of the Observable information. Examples of details captured include identitifying characteristics, time-related attributes, and a list of the tools used to collect the information.  The Description property captures a textual description of the Action. |
| characterizes | Describes the distinctive nature or features of a class or property. Often used to describe classes and properties that themselves comprise one or more other properties. |
|  | *Examples*:  The Action property characterizes a cyber observable Action.  The Obfuscation\_Technique property characterizes a technique an attacker could potentially leverage to obfuscate the Observable. |
| specifies | Used to clearly and precisely identify particular instances or values associated with a property. Often used for properties that are defined by a controlled vocabulary or enumeration; typically used for properties that take on only a single value. |
|  | *Example*:  The cybox\_major\_version property specifies the major version of the CybOX language used for the set of Observables. |

## Terminology

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in [RFC2119].

## Normative References

[RFC2119] Bradner, S., “Key words for use in RFCs to Indicate Requirement Levels”, BCP 14, RFC 2119, March 1997. <http://www.ietf.org/rfc/rfc2119.txt>.

## Non-Normative References

# Background Information

In this section, we provide high level information about the Win Memory Page Region Object data model that is necessary to fully understand the specification details given in Section 3.

## Cyber Observables

A cyber observable is a dynamic event or a stateful property that occurs, or may occur, in the operational cyber domain. Examples of stateful properties include the value of a registry key, the MD5 hash of a file, and an IP address. Examples of events include the deletion of a file, the receipt of an HTTP GET request, and the creation of a remote thread.

A cyber observable is different than a cyber indicator. A cyber observable is a statement of fact, capturing what was observed or could be observed in the cyber operational domain. Cyber indicators are cyber observable patterns, such as a registry key value associated with a known bad actor or a spoofed email address used on a particular date.

## Objects

Objects in CybOX are individual data models for characterizing a particular cyber entity, such as a Windows registry key, or an Email Message. Accordingly, each release of the CybOX language includes a particular set of Objects that are part of the release. The data model for each of these Objects is defined by its own specification that describes the context-specific classes and properties that compose the Object.

# Data Model

## WindowsMemoryPageRegionObjectType Class

The WindowsMemoryPageRegionObjectType class is intended to characterize Windows memory page regions.

The property table of the WindowsMemoryPageRegionObjectType class is given in ???.

Table 3‑1. Properties of the WindowsMemoryPageRegionObjectType class

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Multiplicity** | **Description** |
| **Type** | WinMemoryPageRegionObj:MemoryPageTypeType | 0..1 | The Type property specifies the type of pages in the memory page region. |
| **Allocation\_Base\_Address** | cyboxCommon:HexBinaryObjectPropertyType | 0..1 | The Allocation\_Base\_Address property specifies the base address of the memory page region when the region was first allocated. |
| **Allocation\_Protect** | WinMemoryPageRegionObj:MemoryPageProtectionType | 0..1 | The Allocation\_Protect property specifies the memory protection option for the memory page region when the region was initially allocated. |
| **State** | WinMemoryPageRegionObj:MemoryPageStateType | 0..1 | The State property specifies the state of the memory pages in the region. |
| **Protect** | WinMemoryPageRegionObj:MemoryPageProtectionType | 0..1 | The Protect property specifies the access protection of the memory pages in the region. |

## MemoryPageProtectionType Class

MemoryPageProtectionType specifies memory protection constant classs, via a union of the MemoryPageProtectionEnum type and the atomic xs:string type. Its base type is the CybOX Core BaseObjectPropertyType, for permitting complex (i.e. regular-expression based) specifications.

## MemoryPageStateType Class

MemoryPageStateType specifies memory protection states, via a union of the MemoryPageStateEnum class and the atomic xs:string type. Its base type is the CybOX Core BaseObjectPropertyType, for permitting complex (i.e. regular-expression based) specifications.

## MemoryPageTypeType Class

MemoryPageTypeType specifies memory protection class, via a union of the MemoryPageTypeEnum type and the atomic xs:string type. Its base type is the CybOX Core BaseObjectPropertyType, for permitting complex (i.e. regular-expression based) specifications.

## MemoryPageProtectionEnum Enumeration

The literals of the MemoryPageProtectionEnum enumeration are given in ???.

Table 3‑2. Literals of the MemoryPageProtectionEnum enumeration

|  |  |
| --- | --- |
| **Enumeration Literal** | **Description** |
| **PAGE\_EXECUTE** | From Microsoft: "Enables execute access to the committed region of pages. An attempt to read from or write to the committed region results in an access violation.". |
| **PAGE\_EXECUTE\_READ** | From Microsoft: "Enables execute or read-only access to the committed region of pages. An attempt to write to the committed region results in an access violation.". |
| **PAGE\_EXECUTE\_READWRITE** | From Microsoft: "Enables execute, read-only, or read/write access to the committed region of pages.". |
| **PAGE\_EXECUTE\_WRITECOPY** | From Microsoft: "Enables execute, read-only, or copy-on-write access to a mapped view of a file mapping object. An attempt to write to a committed copy-on-write page results in a private copy of the page being made for the process. The private page is marked as PAGE\_EXECUTE\_READWRITE, and the change is written to the new page.". |
| **PAGE\_NOACCESS** | From Microsoft: "Disables all access to the committed region of pages. An attempt to read from, write to, or execute the committed region results in an access violation.". |
| **PAGE\_READONLY** | From Microsoft: "Enables read-only access to the committed region of pages. An attempt to write to the committed region results in an access violation. If Data Execution Prevention is enabled, an attempt to execute code in the committed region results in an access violation.". |
| **PAGE\_READWRITE** | From Microsoft: "Enables read-only or read/write access to the committed region of pages. If Data Execution Prevention is enabled, attempting to execute code in the committed region results in an access violation.". |
| **PAGE\_WRITECOPY** | From Microsoft: "Enables read-only or copy-on-write access to a mapped view of a file mapping object. An attempt to write to a committed copy-on-write page results in a private copy of the page being made for the process. The private page is marked as PAGE\_READWRITE, and the change is written to the new page. If Data Execution Prevention is enabled, attempting to execute code in the committed region results in an access violation.". |

## MemoryPageStateEnum Enumeration

The literals of the MemoryPageStateEnum enumeration are given in ???.

Table 3‑3. Literals of the MemoryPageStateEnum enumeration

|  |  |
| --- | --- |
| **Enumeration Literal** | **Description** |
| **MEM\_COMMIT** | From Microsoft: "Indicates committed pages for which physical storage has been allocated, either in memory or in the paging file on disk.". |
| **MEM\_FREE** | From Microsoft: "Indicates free pages not accessible to the calling process and available to be allocated. For free pages, the information in the AllocationBase, AllocationProtect, Protect, and Type members is undefined.". |
| **MEM\_RESERVE** | From Microsoft: "Indicates reserved pages where a range of the process's virtual address space is reserved without any physical storage being allocated. For reserved pages, the information in the Protect member is undefined.". |

## MemoryPageTypeEnum Enumeration

The literals of the MemoryPageTypeEnum enumeration are given in ???.

Table 3‑4. Literals of the MemoryPageTypeEnum enumeration

|  |  |
| --- | --- |
| **Enumeration Literal** | **Description** |
| **MEM\_IMAGE** | From Microsoft: "Indicates that the memory pages within the region are mapped into the view of an image section.". |
| **MEM\_MAPPED** | From Microsoft: "Indicates that the memory pages within the region are mapped into the view of a section.". |
| **MEM\_PRIVATE** | From Microsoft: "Indicates that the memory pages within the region are private (that is, not shared by other processes).". |

# Conformance

Implementations have discretion over which parts (components, properties, extensions, controlled vocabularies, etc.) of CybOX they implement (e.g., Observable/Object).

[1] Conformant implementations must conform to all normative structural specifications of the UML model or additional normative statements within this document that apply to the portions of CybOX they implement (e.g., implementers of the entire Observable class must conform to all normative structural specifications of the UML model regarding the Observable class or additional normative statements contained in the document that describes the Observable class).

[2] Conformant implementations are free to ignore normative structural specifications of the UML model or additional normative statements within this document that do not apply to the portions of CybOX they implement (e.g., non-implementers of any particular properties of the Observable class are free to ignore all normative structural specifications of the UML model regarding those properties of the Observable class or additional normative statements contained in the document that describes the Observable class).

The conformance section of this document is intentionally broad and attempts to reiterate what already exists in this document.

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Participants:

Dean Thompson, Australia and New Zealand Banking Group (ANZ Bank)

Bret Jordan, Blue Coat Systems, Inc.

Adnan Baykal, Center for Internet Security (CIS)

Liron Schiff, Comilion (mobile) Ltd.

Jane Ginn, Cyber Threat Intelligence Network, Inc. (CTIN)

Richard Struse, DHS Office of Cybersecurity and Communications (CS&C)

Ryusuke Masuoka, Fujitsu Limited

Eric Burger, Georgetown University

Jason Keirstead, IBM

Paul Martini, iboss, Inc.

Jerome Athias, Individual

Sanjiv Kalkar, Individual

Terry MacDonald, Individual

Alex Pinto, Individual

Patrick Maroney, Integrated Networking Technologies, Inc.

Wouter Bolsterlee, Intelworks BV

Joep Gommers, Intelworks BV

Sergey Polzunov, Intelworks BV

Rutger Prins, Intelworks BV

Andrei Sîrghi, Intelworks BV

Jonathan Baker, MITRE Corporation

Sean Barnum, MITRE Corporation

Mark Davidson, MITRE Corporation

Ivan Kirillov, MITRE Corporation

John Wunder, MITRE Corporation

Mike Boyle, National Security Agency

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Takahiro Kakumaru, NEC Corporation

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Christian Hunt, New Context Services, Inc.

Andrew Storms, New Context Services, Inc.

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Bernd Grobauer, Siemens AG

John Anderson, Soltra

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Paul Dion, Soltra

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Ali Khan, Soltra

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