Secure Data Aggregation Protocol for Sensor Networks

Introduction

- Ubiquitous Computing - is a scenario in which computing is omnipresent.
- Internet of Things - is a system where the Internet is connected to physical world via ubiquitous sensors.
- Ad-hoc Networking - is a local network of sensors formed by peer-to-peer communications.
- Sensor Networks - Collectively, we refer these concept as Sensor Networks.

Sensor Networks

In sensor networks, thousands of sensors may interact with each other and collects raw data.

The data is processed by computationally powerful machine (the base station).

Then the base station converts data into information.

Based on the information an important action is taken.

Figure 1: Sensor Network

Sensor Networks Applications

Military - enemy tracking, battle filed surveillance or target classification.

Environmental - to monitor geographical location without much human intervention.

Health Care - to monitor patients around the clock, send reminders to doctors and nurses.

Sustainable Mobility - to build digitally connected and coordinated vehicles.

Catastrophic Event

Speed sensor failure led to crash of Air France flight - Airbus A330-203 AF 447 on 1st June 2009.

France's Bureau of Investigation and Analysis (BEA) reported, the pilots could not reclaim control as the plane dropped out of the sky at a rate of $10,000$ feet per minute.

The findings from the flight's black boxes, and their analysis paints a harrowing picture of Air France flight 447's literal dropping out of the sky.

The co-pilots encountered trouble with the speed sensors four hours and 10 minutes into the flight.

For nearly a minute, as the speed sensors jumped, the pilot was not present in the cockpit.

By the time the pilot returned, the plane had started to fall at $10,000$ feet per minute while violently rolling from side to side.

The plane's speed sensors never regained normal functionality as the plane began its three-and-a-half minute freefall.

The flight plunged into the Atlantic nose-up, killing all 228 on board.

Resource Constrains in Sensor Network

Physical Limitations - often deployed in open, hostile and unattended environments. Vulnerable to physical tampering due to the lower physical security.

Hardware Limitations - due to lower manufacturing cost of sensor nodes, they have low speed processor, limited storage, a short range trans receivers.

Transmission Medium - sensors communicate over the wireless network using radio which has issues with synchronization, hidden station and expose station terminal problems, directional antennas, bandwidth limitations, higher error rate, security, scalability etcetera. For example, wireless networks have approximately 10^6 times higher bit error rate (BER) than wired networks which causes frequent link loss and then path loss.

Mobility - network topology is dynamic, topology changes due to link failure, node failure or bandwidth optimization. It makes difficult to do the routing in the network. It requires the network to be agile enough to do the reconfiguration for the network topology.

Cryptographic Tools

Cryptanalysis is the science breaking of cryptography schemes. Formally, the basic component of cryptography is a cryptosystem.

Definition 0.1. *A cryptosystem is a 5-tuple $(\mathcal{E}, \mathcal{D}, \mathcal{M}, \mathcal{K}, \mathcal{C})$, where $\mathcal{M}$ is the set of plaintexts, $\mathcal{K}$ is the set of keys, $\mathcal{C}$ is the set of ciphertexts, $\mathcal{E} : \mathcal{M} \times \mathcal{K} \to \mathcal{C}$ is the set of enciphering functions, and $\mathcal{D} : \mathcal{C} \times \mathcal{K} \to \mathcal{M}$ is the set of deciphering functions.*

Symmetric Key And Asymmetric Key Encryption

Consider an encryption scheme consisting of the sets of encryption and decryption transformations $\{E_e : e \in \mathcal{K}\}$ and $\{D_d : d \in \mathcal{K}\}$, respectively, where $\mathcal{K}$ is the key space.

The encryption scheme is said to be **Symmetric-Key** if for each associated encryption/decryption key pair (e, d), it is computationally "easy" to determine d given e, and to determine e from d. Moreover, most symmetric-key schemes satisfy $e = d$.

The encryption scheme is said to be **Asymmetric-Key** if for any pair of associated encryption/decryption transformations (E_e, D_d) and assuming each pair has the property that knowing E_e it is computationally infeasible, given a random ciphertext $c \in \mathcal{C}$, to find the message $m \in \mathcal{M}$ such that $E_e(m) = c$. This property implies that given e it is infeasible to determine the corresponding decryption key d.

Hash Functions

A hash function takes a message as its input and outputs a fixed length message called hash code. The hash code represents a compact image of the message like a digital fingerprint. Hash functions are essential mathematical tools to achieve data integrity. A hash function h should have the following properties :

Compression A hash function h maps an input x of arbitrary finite bitlength, to an output $h(x)$ of fixed bitlength n.

Ease of computation For given h, x it is easy to compute $h(x)$.

Preimage resistance For all pre-specified outputs, it is computationally infeasible to find any input which hashes to that output, i.e., to find any preimage x' such that $h(x') = y$ where y is given whose corresponding input is not known.

2nd-preimage resistance It is computationally infeasible to find any second input which has the same output as any specified input, i.e, given x, to find a 2nd-preimage $x' \neq x$ such that $h(x') = h(x)$.

Collision resistance It is computationally to find any two distinct inputs x, x' which hash to the same output, i.e., such that $h(x) = h(x')$.

SHA-256, is a 256-bit hash and provides 128 bits of security against collision attacks.

Message Authentication Codes

A Message Authentication Code (MAC) is a family of hash functions parameterized by a secret key k, also known as keyed hash function (h_k). It has the following properties :

Ease of computation For a known function h_k, given a value k and an input x, $h_k(x)$ is easy to compute. This result is called MAC.

Compression The function h_k maps an input x of arbitrary finite bitlength to an output $h_k(x)$ of fixed length n.

Computation-resistance Given a description of the function family h, for every fixed allowable value of k (unknown to an adversary), given zero or more text-MAC pairs $(x_i, h_k(x_i))$, it is computationally infeasible to compute any text-MAC pair $(x, h_k(x))$ for any new input $x \neq x^{'}$ (including possibly for $h_k(x) = h_k(x_i)$ for some i). If computation-resistance does not hold, a MAC algorithm is subject to MAC-forgery.

Digital Signatures

A digital signature is a cryptographic scheme for demonstrating the authenticity of a digital message.
A valid digital signature gives a recipient strong reason to believe that the message was created by a known sender, such that the sender cannot deny having sent the message (authentication and non-repudiation) and that the message was not altered in transit (integrity).
A Digital Signature scheme consists of the following :

1. a plain text message space $\mathcal{M}$ (set of strings over alphabets)
2. a signature space $\mathcal{S}$ (set of possible signatures)
3. a signing key space $\mathcal{K}$ (set of possible keys for signature generation) and a verification space $\mathcal{K}^{'}$ (a set of possible verification keys)
4. an efficient key generation algorithm Gen : $N \rightarrow \mathcal{K} \times \mathcal{K}^{'}$
5. an efficient signing algorithm Sign : $\mathcal{M} \times \mathcal{K} \rightarrow \mathcal{S}$
6. an efficient verification algorithm Verify : $\mathcal{S} \times \mathcal{M} \rightarrow \{\text{true, false}\}$

For any secret key $s_k \in \mathcal{K}$ and any $m \in \mathcal{M}$, the message m is signed using key s_k as follows:

$$s = \text{Sign}_{s_k}(m) \tag{1}$$

For any s_k let p_k denote public key and for all $m \in \mathcal{M}$ and $s \in \mathcal{S}$, s as follows:

$$\text{Verify}_{p_k}(m, s) = \begin{cases} \textbf{true} \text{ with probability of 1} & \text{if } s = \text{Sign}_{s_k}(m) \\ \textbf{false} \text{ with overwhelming probability} & \text{if } s \neq \text{Sign}_{s_k}(m) \end{cases} \tag{2}$$

where the probability space is determine by the $\mathcal{M}, \mathcal{S}, \mathcal{K}, \mathcal{K}'$ and perhaps the signing and verification algorithms.

The “overwhelming probability” for the signature scheme determines the probability that the scheme allows for a forgery.

The message is hashed before its being signed to reduce the message size. If the message is not hashed before signing then the signature can be longer than the message which is problematic for the longer messages.

Summary

Three different integrity-protection mechanisms HASH, MAC, Signature can be summarized in a matrix like Table 1.

The main difference between the various primitives stems from identifying who can generate the code and who can verify it.

	Who can generate it	Who can verify it
Hash	Everyone	Everyone
MAC	Holders of secret	Holders of secret
Signature	Holder of secret	Everyone

Table 1: A comparison of integrity-protecting primitives

LaTeX Workshop

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LaTeX

- A document typesetting system –
- Open Source software
  - ♢ available Windows, Unix/Linux, Mac,
- high-quality: camera-ready output
- can produce a number of different outputs PostScript, PDF, HTML, etc
- there exists packages that support thesis, music, chemistry,....

Benefits of LaTeX

- Excellent for producing thesis quality, journal article, conference paper
- can produce books and online content (HTML, PDF)
- Standard styles (such as IEEE) available
- High quality results with little effort
- trivial to modify article from one style to another (see experiment)

How does it work? What do you need?

- Authors write documents – require editor turn extensions on in your computer
- Run a LaTeXprocessor to produce a device-independent file (dvi) or run `pdflatex` to produce a `pdf` or run `xelatex` to produce `pdf` (when using images that are `.eps`)
- for a dvi file use a previewer like YAP to view the dvi file
- Edit, Process, Preview cycle during production
- **what do we need? editor....textpad, notepad, emacs, VI editor, crimson editor,texworks...**
- to `pdflatex` use texworks or...
  - open command window, change the directory to folder containing file

  `cd C:\Documents and Settings\bk\Desktop\latex_work`

  execute the `pdflatex file_name` command

Where to get it

Miktex http://miktex.org/

to download http://miktex.org/download

download installer

run

will download latex, ...

also texworks a editor, latex builder, etc

What does ”tex” look like? (from wikipedia)

```
\documentclass[12pt]{article}
\usepackage{amsmath}
\title{\LaTeX}
\date{}
\begin{document}
  \maketitle
  \LaTeX{} is a document preparation system for the \TeX{}
  typesetting program. It offers programmable desktop publishing
  features and extensive facilities for automating most aspects of
  typesetting and desktop publishing, including numbering and
  cross-referencing, tables and figures, page layout, bibliographies,
  and much more. \LaTeX{} was originally written in 1984 by Leslie
  Lamport and has become the dominant method for using \TeX; few
  people write in plain \TeX{} anymore. The current version is
  \LaTeXe.

  % This is a comment, it is not shown in the final output.
   The following shows a little of the typesetting power of LaTeX
  \begin{align}
    E &= mc^2    \\
    m &= \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}
  \end{align}
\end{document}
```

LaTeX is designed to separate content from presentation

The author should focus on the text and structure

Layout, fonts and presentation determined by style

De facto standard for many disciplines in academia

Also gaining acceptance in publishing houses Computer Science, Engineering, Physics, Mathematics all have very demanding typesetting requirements

LaTeX allows publishers to provide style file and produce high-quality consistent results for conferences, journals, etc.

Many commands are followed by arguments

```
\command{argument}
```

```
\section*{My first document}
\url{http://www.silmaril.ie/downloads/}
```

Defining the Document

LaTeX needs the document to be defined in order to properly process the document. This is the first item defined in a LaTeX document and it's defined with the command

```
\documentclass[options]{class}.
```

Document Classes

article: for conference and other presentations, short reports, anything written that's relatively small and less formatted (around 1-20 pages, no chapter breaks)

report: for longer works containing several chapters, small books, PhD dissertations, Master's theses book for real books

seminar: for slides.

Document Class Options

SKIP

10pt, 11pt, 12pt: This sets the size of the main font in the document. If no option is specified, 10pt is assumed.

letterpaper, legalpaper: This defines the paper size. The default size is letterpaper. a5paper, b5paper, executivepaper, and legalpaper can be specified.

fleqn: This is used for papers with mathematical formulae. This typesets displayed formulae left-aligned instead of centred. leqno Places the numbering of formulae on the left hand side instead of the right.

titlepage, notitlepage: This specifies whether a new page should be started after the document title or not. The article class does not start a new page by default, while report and book do.

onecolumn, twocolumn: This tells LaTeX to typeset the document in one column or two columns and is used most often for specific typesetting needs.

twoside, oneside: This specifies whether double or single sided output should be generated. The classes article and report are single sided and the book class is double sided by default. Note that this option concerns the style of the document only. The option twoside does not tell the printer you use that it should actually make a two-sided printout.

landscape: This changes the layout of the document to print in landscape mode.

openright, openany: This makes chapters begin either only on right hand pages or on the next page available. This does not work with the article class, as it does not know about chapters. The report class by default starts chapters on the next page available and the book class starts them on right hand pages.

Page Styles

LaTeX supports three predefined header/footer combinations, which are often called page styles. The style parameter of the command defines which one to use. The command to call a page style is:

```
\pagestyle{style}
```

The predefined page styles are:

plain: This prints the page numbers on the bottom of the page, in the middle of the footer. This is the default page style.

headings: This prints the current chapter heading and the page number in the header on each page, while the footer remains empty. (This is the style used in this document)

empty: This sets both the header and the footer to be empty.

LaTeX preamble

```
\documentclass[12pt]{article}
\usepackage{url,graphicx,amsmath}
\begin{document}
```

your text will lie between `\begin{document}` and `\end{document}`

for every `\begin{..}` there should be a `\end{...}`

```
\documentclass[12pt]{article}
\usepackage{palatino,url}
\begin{document}
\section*{My first document}
This is a short example of a \LaTeX\ document
I wrote on \today. It shows a few simple features
of automated typesetting, including

\begin{itemize}
\item setting the default font to 12pt;
\item specifing ‘article’ type formatting;
\item using the palatino typeface;
\item adding special formatting for URLs;
\item formatting a deading in ‘section’ style;
\item using the \LaTeX\ logo;
\item generating today’s date;
\item centering and italicizing;
\item autonumbering the pages.
\end{itemize}

\subsection*{More information}

This example was taken from ‘Formatting Information,’
which you can download from \url{http://www.silmaril.ie/downloads/}
and use as a teach-yourself guide.

\clearpage

\begin{center}
```

```
\itshape Have a nice day!
\end{center}

\end{document}
```

My first document

This is a short example of a LaTeX document I wrote on February 17, 2015. It shows a few simple features of automated typesetting, including

- setting the default font to 12pt;
- specifing ‘article’ type formatting;
- using the palatino typeface;
- adding special formatting for URLs;
- formatting a deading in ‘section’ style;
- using the LaTeX logo;
- generating today’s date;
- centering and italicizing;
- autonumbering the pages.

More information

This example was taken from ‘Formatting Information,’ which you can download from http://www.silmaril.ie/downloads/ and use as a teach-yourself guide.

Have a nice day!

Symbols

- Extensive symbol libraries available

Graphics

- Import: photos, graphs, diagrams, charts, etc.
- Generate: diagrams, figures, etc.
- Formats: many common image formats supported

Bibliography

SKIP

- BibTeX is a textual database of references
- Bibliographies are generated for each document
- Citation style determined by bib style
- EndNote can export to BibTeX
- Online citation databases provide BibTeX references

Transparencies

SKIP

- This presentation was produced with LaTeX and seminar packages
- Easily produce slides
- Generate for online viewing or printing to transparencies
- Various styles available
- Customize layout, fonts, colors, etc

Output

LaTeX can generate a variety of output formats

DVI: device independent (preview, print, convert)

HTML: produce online books and articles

PostScript: for printing

PDF: online display, presentations, exchange

Links

To download LaTeXfor the PC/Windows

`http://miktex.org/`

Purdue Thesis Class

`https://engineering.purdue.edu/~mark/puthesis/`

Quick introduction

- there are a number of reserved symbols
- `$`

  the $ initiates math mode, the $ terminates math mode

  example

```
my favorite function is
$f(x) =\log x +\cos 2\theta +\frac{x-2}{2x+1}$
```

output is

my favorite function is $f(x) = \log x + \cos 2\theta + \frac{x-2}{2x+1}$

- A paragraph is created by inserting a blank line (a single blank line cause a new paragraph, there is no additional effect by having more than one blank line
- % will comment out all content on the line to the right of %
- `\\` starts a new line, this has a difference between starting a paragraph
- empty line starts a new paragraph

- multiple empty lines are equivalent to one empty line,

α	\alpha	θ	\theta	o	o	τ	\tau
β	\beta	ϑ	\vartheta	π	\pi	υ	\upsilon
γ	\gamma	γ	\gamma	ϖ	\varpi	ϕ	\phi
δ	\delta	κ	\kappa	ρ	\rho	φ	\varphi
ϵ	\epsilon	λ	\lambda	ϱ	\varrho	χ	\chi
ε	\varepsilon	μ	\mu	σ	\sigma	ψ	\psi
ζ	\zeta	ν	\nu	ς	\varsigma	ω	\omega
η	\eta	ξ	\xi				
Γ	\Gamma	Λ	\Lambda	Σ	\Sigma	Ψ	\Psi
Δ	\Delta	Ξ	\Xi	Υ	\Upsilon	Ω	\Omega
Θ	\Theta	Π	\Pi	Φ	\Phi		

Table 2: Greek Letters

$\pm$	\pm	$\cap$	\cap	$\diamond$	\diamond	$\oplus$	\oplus
$\mp$	\mp	$\cup$	\cup	$\triangle$	\bigtriangleup	$\ominus$	\ominus
$\times$	\times	$\uplus$	\uplus	$\triangledown$	\bigtriangledown	$\otimes$	\otimes
$\div$	\div	$\sqcap$	\sqcap	$\triangleleft$	\triangleleft	$\oslash$	\oslash
$*$	\ast	$\sqcup$	\sqcup	$\triangleright$	\triangleright	$\odot$	\odot
$\star$	\star	$\vee$	\vee	$\lhd$ [b]	\lhd	$\bigcirc$	\bigcirc
$\circ$	\circ	$\wedge$	\wedge	$\rhd$ [b]	\rhd	$\dagger$	\dagger
$\bullet$	\bullet	$\setminus$	\setminus	$\unlhd$ [b]	\unlhd	$\ddagger$	\ddagger
$\cdot$	\cdot	$\wr$	\wr	$\unrhd$ [b]	\unrhd	$\amalg$	\amalg
$+$	+	$-$	-				

[b] Not predefined in a format based on `basefont.tex`. Use one of the style options `oldlfont`, `newlfont`, `amsfonts` or `amssymb`.

Table 3: Binary Operation Symbols

$\leq$	\leq	$\geq$	\geq	$\equiv$	\equiv	$\models$	\models
$\prec$	\prec	$\succ$	\succ	$\sim$	\sim	$\perp$	\perp
$\preceq$	\preceq	$\succeq$	\succeq	$\simeq$	\simeq	$\mid$	\mid
$\ll$	\ll	$\gg$	\gg	$\asymp$	\asymp	$\parallel$	\parallel
$\subset$	\subset	$\supset$	\supset	$\approx$	\approx	$\bowtie$	\bowtie
$\subseteq$	\subseteq	$\supseteq$	\supseteq	$\cong$	\cong	$\Join$	\Join[b]
$\sqsubset$	\sqsubset[b]	$\sqsupset$	\sqsupset[b]	$\neq$	\neq	$\smile$	\smile
$\sqsubseteq$	\sqsubseteq	$\sqsupseteq$	\sqsupseteq	$\doteq$	\doteq	$\frown$	\frown
$\in$	\in	$\ni$	\ni	$\propto$	\propto	$=$	=
$\vdash$	\vdash	$\dashv$	\dashv	$<$	<	$>$	>
:	:						

[b] Not predefined in a format based on `basefont.tex`. Use one of the style options `oldlfont`, `newlfont`, `amsfonts` or `amssymb`.

Table 4: Relation Symbols

,	,	;	;	:	\colon
.	\ldotp	·	\cdotp		

Table 5: Punctuation Symbols

←	\leftarrow	⟵	\longleftarrow	↑	\uparrow
⇐	\Leftarrow	⟸	\Longleftarrow	⇑	\Uparrow
→	\rightarrow	⟶	\longrightarrow	↓	\downarrow
⇒	\Rightarrow	⟹	\Longrightarrow	⇓	\Downarrow
↔	\leftrightarrow	⟷	\longleftrightarrow	↕	\updownarrow
⇔	\Leftrightarrow	⟺	\Longleftrightarrow	⇕	\Updownarrow
↦	\mapsto	⟼	\longmapsto	↗	\nearrow
↩	\hookleftarrow	↪	\hookrightarrow	↘	\searrow
↼	\leftharpoonup	⇀	\rightharpoonup	↙	\swarrow
↽	\leftharpoondown	⇁	\rightharpoondown	↖	\nwarrow
⇌	\rightleftharpoons	⇝	\leadsto[b]		

[b] Not predefined in a format based on `basefont.tex`. Use one of the style options `oldlfont`, `newlfont`, `amsfonts` or `amssymb`.

Table 6: Arrow Symbols

$\ldots$	`\ldots`	$\cdots$	`\cdots`	$\vdots$	`\vdots`	$\ddots$	`\ddots`
$\aleph$	`\aleph`	$\prime$	`\prime`	$\forall$	`\forall`	∞	`\infty`
$\hbar$	`\hbar`	$\emptyset$	`\emptyset`	$\exists$	`\exists`	$\Box$	`\Box`^{b}
$\imath$	`\imath`	∇	`\nabla`	$\neg$	`\neg`	$\Diamond$	`\Diamond`^{b}
$\jmath$	`\jmath`	$\surd$	`\surd`	$\flat$	`\flat`	$\triangle$	`\triangle`
ℓ	`\ell`	$\top$	`\top`	$\natural$	`\natural`	$\clubsuit$	`\clubsuit`
$\wp$	`\wp`	$\bot$	`\bot`	$\sharp$	`\sharp`	$\diamondsuit$	`\diamondsuit`
$\Re$	`\Re`	$\|$	`|`	$\backslash$	`\backslash`	$\heartsuit$	`\heartsuit`
$\Im$	`\Im`	$\angle$	`\angle`	∂	`\partial`	$\spadesuit$	`\spadesuit`
$\mho$	`\mho`^{b}	.	.	$\|$	`|`		

^{b} Not predefined in a format based on `basefont.tex`. Use one of the style options `oldlfont`, `newlfont`, `amsfonts` or `amssymb`.

Table 7: Miscellaneous Symbols

$\sum$	\sum	$\bigcap$	\bigcap	$\bigodot$	\bigodot
$\prod$	\prod	$\bigcup$	\bigcup	$\bigotimes$	\bigotimes
$\coprod$	\coprod	$\bigsqcup$	\bigsqcup	$\bigoplus$	\bigoplus
$\int$	\int	$\bigvee$	\bigvee	$\biguplus$	\biguplus
$\oint$	\oint	$\bigwedge$	\bigwedge		

Table 8: Variable-sized Symbols

\arccos	\cos	\csc	\exp	\ker	\limsup	\min	\sinh
\arcsin	\cosh	\deg	\gcd	\lg	\ln	\Pr	\sup
\arctan	\cot	\det	\hom	\lim	\log	\sec	\tan
\arg	\coth	\dim	\inf	\liminf	\max	\sin	\tanh

Table 9: Log-like Symbols

(	(	)	)	↑	\uparrow	⇑	\Uparrow
[	[	]	]	↓	\downarrow	⇓	\Downarrow
{	\{	}	\}	↕	\updownarrow	⇕	\Updownarrow
⌊	\lfloor	⌋	\rfloor	⌈	\lceil	⌉	\rceil
⟨	\langle	⟩	\rangle	/	/	\	\backslash
|	|	‖	\\|			

Table 10: Delimiters

⟮	\rmoustache	⟯	\lmoustache	⟯	\rgroup	⟮	\lgroup
|	\arrowvert	‖	\Arrowvert	❙	\bracevert		

Table 11: Large Delimiters

$\hat{a}$	`\hat{a}`	$\acute{a}$	`\acute{a}`	$\bar{a}$	`\bar{a}`	$\dot{a}$	`\dot{a}`	$\breve{a}$	`\breve{a}`
$\check{a}$	`\check{a}`	$\grave{a}$	`\grave{a}`	$\vec{a}$	`\vec{a}`	$\ddot{a}$	`\ddot{a}`	$\tilde{a}$	`\tilde{a}`

Table 12: Math mode accents

$\widetilde{abc}$	`\widetilde{abc}`	$\widehat{abc}$	`\widehat{abc}`
$\overleftarrow{abc}$	`\overleftarrow{abc}`	$\overrightarrow{abc}$	`\overrightarrow{abc}`
$\overline{abc}$	`\overline{abc}`	$\underline{abc}$	`\underline{abc}`
$\overbrace{abc}$	`\overbrace{abc}`	$\underbrace{abc}$	`\underbrace{abc}`
$\sqrt{abc}$	`\sqrt{abc}`	$\sqrt[n]{abc}$	`\sqrt[n]{abc}`
f'	`f'`	$\frac{abc}{xyz}$	`\frac{abc}{xyz}`

Table 13: Some other constructions