Numerical Method and Simulation Analysis
Final Presentation

Files Transition Platform with Encryption

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一、系統架構

（位置：\Files_Transition_Platform）

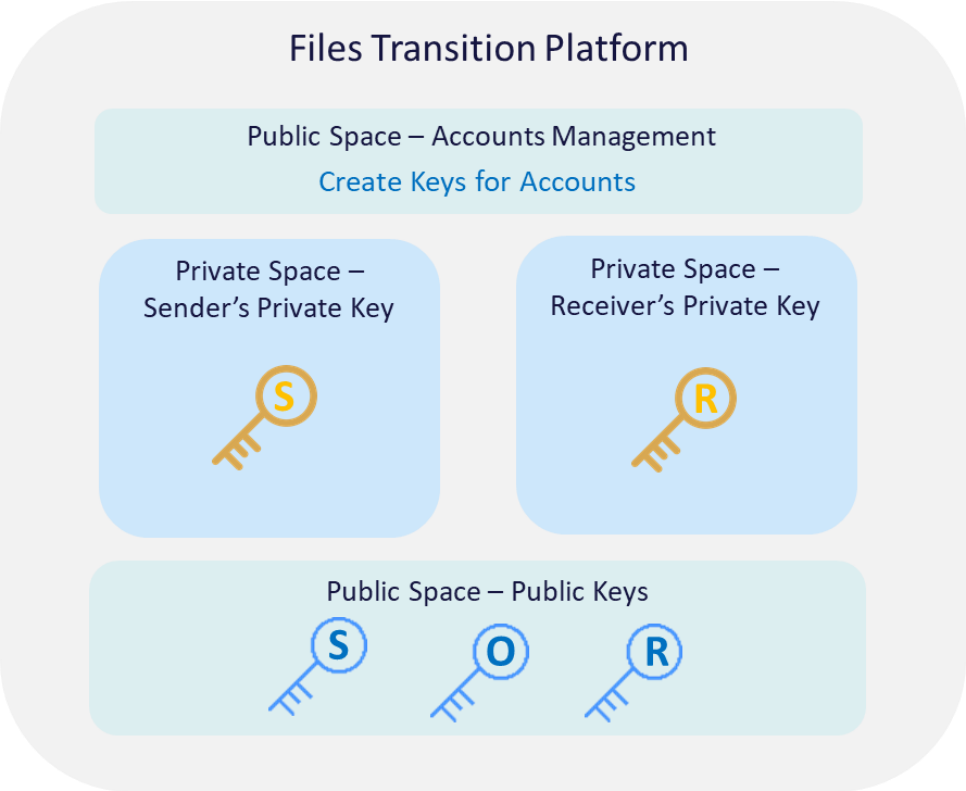


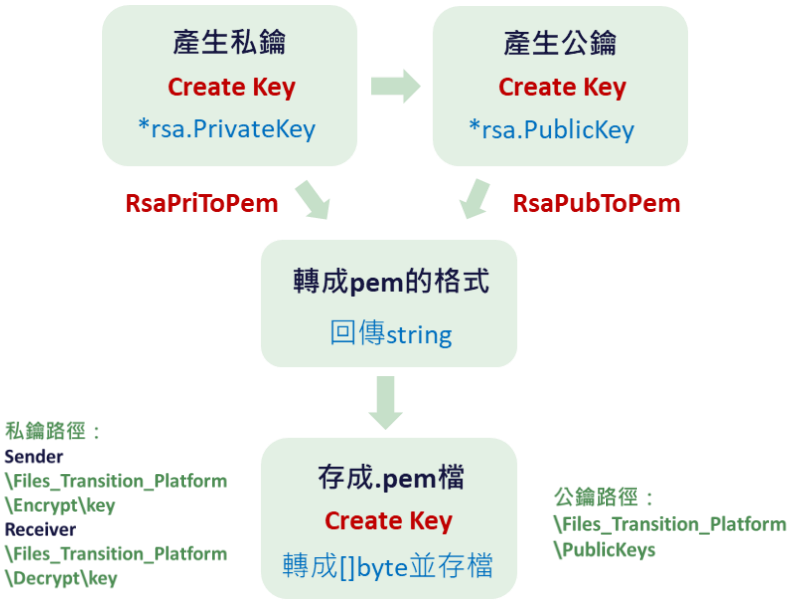
Figure 1 系統架構示意圖

：私鑰 ：公鑰 ：其他公鑰

二、執行流程

1. 產生私鑰及公鑰，並儲存成.pem 檔（沛萱）

(詳第三章 1. management.go **路徑：\Files_Transition_Platform\Account_Managment\management.go**)



註：私鑰存至私人區域（\Encrypt\key or \Decrypt\key），公鑰存至公開區域(\PublicKeys)

Figure 2 產生公、私鑰流程圖

CreateKey：

```
func CreateKey(who , folder string, size int) {
        newPrivkey, err := rsa.GenerateKey(rand.Reader, size)
        Check(err)

        // create pem file
        PemRrikey := []byte(RsaPriToPem(newPrivkey))

        newPubkey := &newPrivkey.PublicKey
        PemPubkey := []byte(RsaPubToPem(newPubkey))

        err = ioutil.WriteFile("../"+folder+"/key/"+who+"pri_key.pem",  PemRrikey, 0644)

        if err != nil {
                fmt.Printf("Error creating Key file!")
                os.Exit(0)
        } else {
                err = ioutil.WriteFile("../PublicKeys/"+who+"pub_key.pem",  PemPubkey, 0644)
        }
}
```

RsaPriToPem：

```
func RsaPriToPem (rsaPrivkey *rsa.PrivateKey) string {
  privkey_bytes := x509.MarshalPKCS1PrivateKey(rsaPrivkey)

  privkey_pem := pem.EncodeToMemory(
      &pem.Block{
          Type:  "RSA PRIVATE KEY",
          Bytes: privkey_bytes,
      },
  )
  return string(privkey_pem)
}
```

RsaPubToPem：

```
func RsaPubToPem (rsaPubkey *rsa.PublicKey) string {
  pubkey_bytes, err := x509.MarshalPKIXPublicKey(rsaPubkey)
  Check(err)

  pubkey_pem := pem.EncodeToMemory(
      &pem.Block{
          Type:  "RSA PUBLIC KEY",
          Bytes: pubkey_bytes,
      },
  )

  return string(pubkey_pem)
}
```

以上轉換格式程式參考網址：
https://stackoverflow.com/questions/13555085/save-and-load-crypto-rsa-privatekey-to-and-from-the-disk

Table 1 management.go 函數輸出輸入格式整理

函數名稱	輸入格式	輸出格式/動作
RsaPriToPem	*rsa.PrivateKey	string
CreateKey	*rsa.PublicKey	string
CreateKey	string	存出.pem檔案

2. 加密檔案，並輸出.zip 檔（沛萱）

(詳第三章 2. encrypt.go **路徑：\Files_Transition_Platform\Encrypt\encrypt.go**)

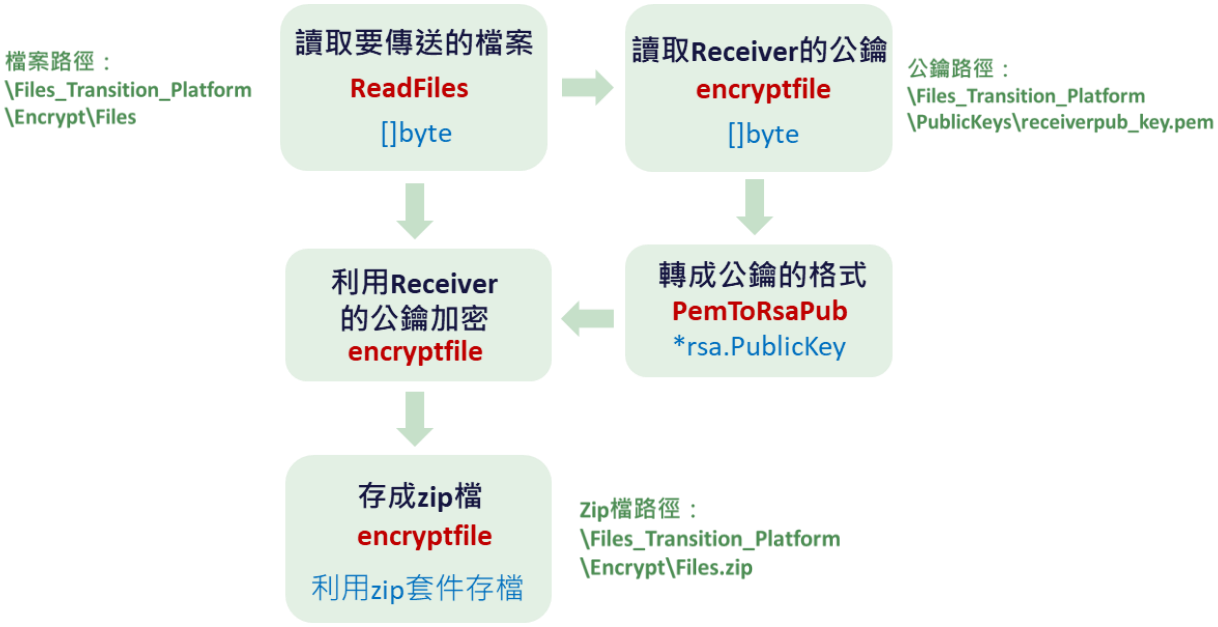


Figure 3 加密流程示意圖

encryptfile：

```
// Encrypt Files and Compress
func encryptfile(folder string) {

    // Read files
    FileData, FileName := ReadFiles(folder)

    // encrypt and zip files
    fzip, _ := os.Create(folder+"(encrypt).zip")
    w := zip.NewWriter(fzip)
     defer w.Close()
     for i, filedata := range FileData {
     fw, _ := w.Create(FileName[i])

      // encrypt file
      // hash_data := sha256.Sum256(filedata)
      // https://ithelp.ithome.com.tw/articles/10188698
      encryptedmsg, err := rsa.EncryptPKCS1v15(rand.Reader, ReceiverPubkey, filedata[:])
      Check(err)

      _, err = fw.Write(encryptedmsg)
      Check(err)
      // fmt.Println(n)
   }
}
```

ReadFiles：

```
// Read Files
func ReadFiles(folder string) ([][]byte, []string) {

    dir := folder+"/"
    files, err := ioutil.ReadDir(dir)
    fmt.Println(files,"\nlen=",len(files))

    Check(err)

    FileData := [][]byte{}
    FileName := []string{}
    for _, file := range files {
            filecontent, err := ioutil.ReadFile(dir + file.Name())
            Check(err)

            FileData = append(FileData, filecontent)
            FileName = append(FileName, "Crypt_"+ file.Name())
            }
    return FileData, FileName
}
```

PemToRsaPub：

```
func PemToRsaPub (pubPEM string) (*rsa.PublicKey, error) {
    block, _ := pem.Decode([]byte(pubPEM))
    if block == nil {
        return nil, errors.New("failed to parse PEM block containing the key")
    }

    pub, err := x509.ParsePKIXPublicKey(block.Bytes)
    if err != nil {
        return nil, err
    }

    fmt.Println("pub=",pub)

    switch pub := pub.(type) {
    case *rsa.PublicKey:
        return pub, nil
    default:
        break // fall through
    }

    return nil, errors.New("Key type is not RSA")
}
```

Table 2 encrypt.go 函數輸出輸入格式整理

函數名稱	輸入格式	輸出格式/動作
PemToRsaPub	string （讀取後的.pem檔）	*rsa.PublicKey
rsa.EncryptPKCS1v15	*rsa.PublicKey	傳出加密檔案

3. 傳送檔案

本次報告使用 USB 傳送。

4. 解密檔案（豐育）

(詳第三章 3. decrypt.go，檔案路徑：" \Files_Transition_Platform\Decrypt\decrypt.go")

方法一：

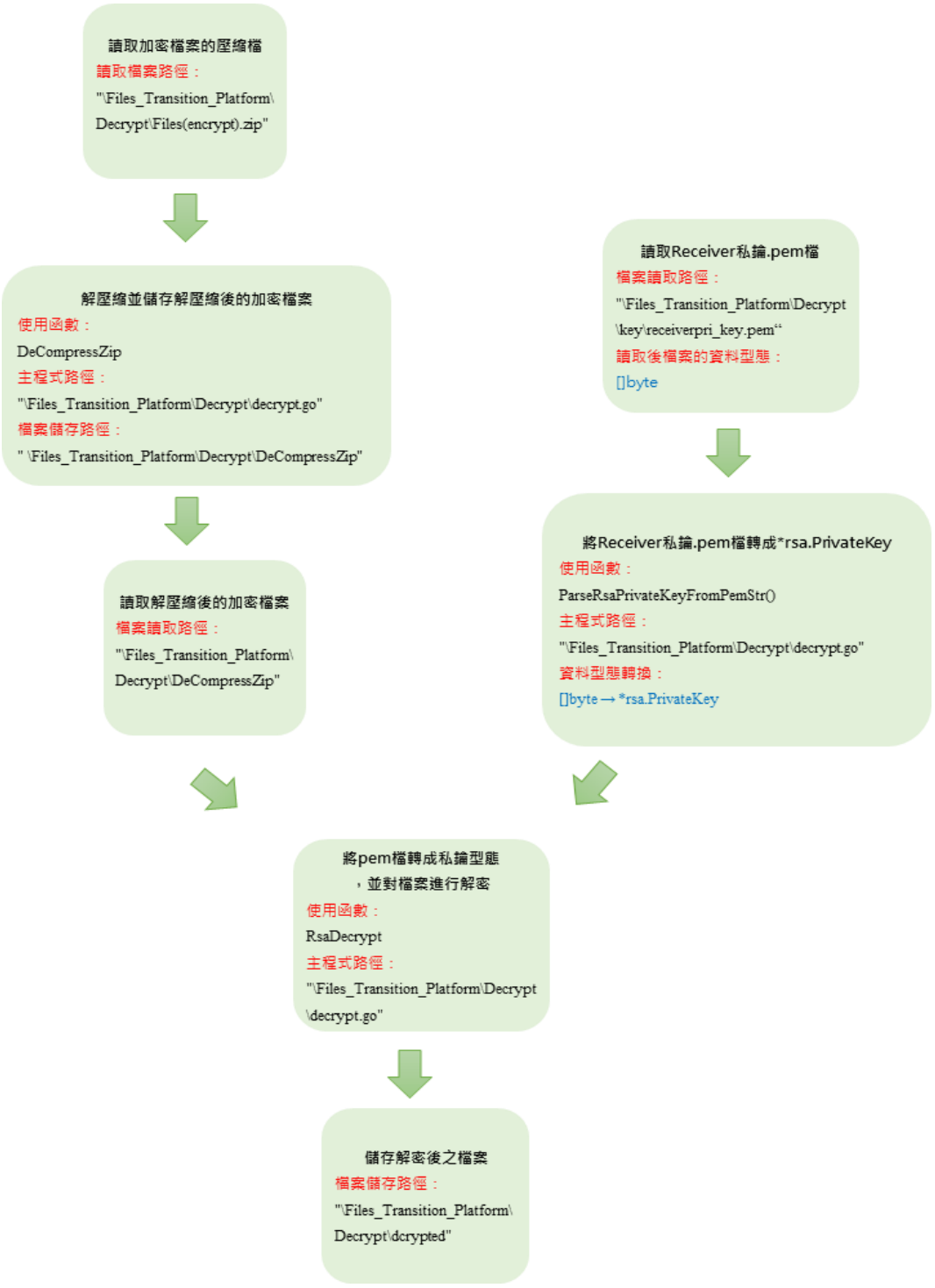


Figure 4 解壓縮流程圖(方法一)

方法二：

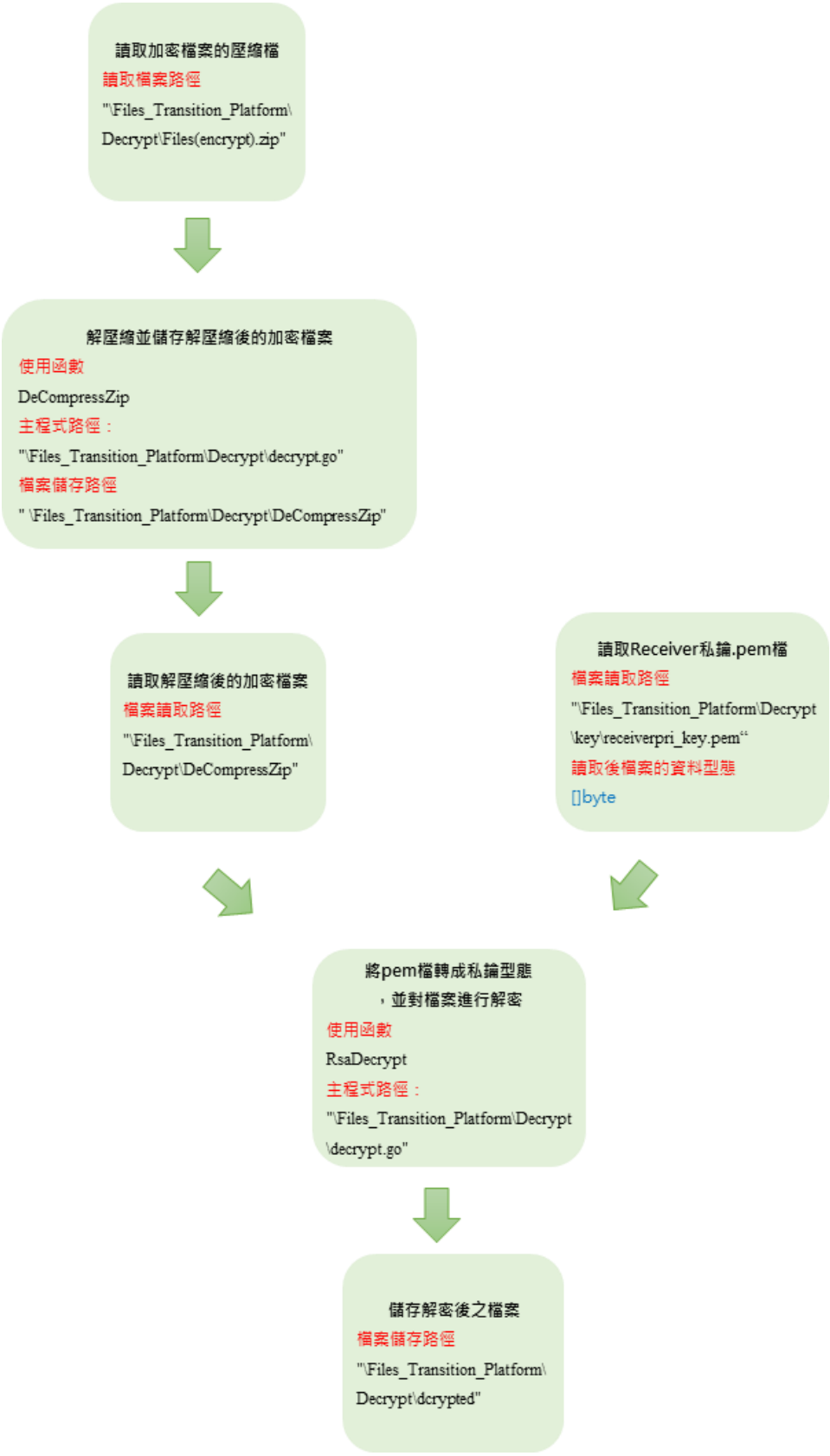


Figure 5 解壓縮流程圖(方法二)

a. 解壓縮

```
func DeCompressZip(File, dir string) {

    os.Mkdir(dir, 0777) //建立一個目錄（資料夾）

    cf, err := zip.OpenReader(File) //讀取zip檔案
    if err != nil {
        fmt.Println("Func DeCompressZip rader")
        fmt.Println(err)
    }
    defer cf.Close()
    for _, file := range cf.File {
        rc, err := file.Open() //開檔
        if err != nil {
            fmt.Println("Func DeCompressZip open")
            fmt.Println(err)
        }

        f, err := os.Create(dir + "/" + file.Name) //開檔案位置
        if err != nil {
            fmt.Println("Func DeCompressZip os.Create")
            fmt.Println(err)
        }
        defer f.Close()           //關檔
        n, err := io.Copy(f, rc) //覆寫
        if err != nil {
            fmt.Println("Func DeCompressZip io.Copy")
            fmt.Println(err)
        }
        fmt.Println(n)
    }

}
```

由網路上找到的解壓縮方法，可以將檔案解壓縮後儲存至指定的 dir 路徑，若無相對應資料夾，則透過 os.Mkdir()函數會自動生成新資料夾。
參考資料：example:https://www.itread01.com/content/1546726868.html

b. 讀取解壓縮後檔案

```
list, err := ioutil.ReadDir(path) //ioutil.ReadDir讀資料夾、ioutil.ReadFile讀單一檔案 ; 用list叫出資料夾的基本性質
if err != nil {                   //https://blog.csdn.net/yxys01/article/details/78136295
    fmt.Println("Read DeCompressZip")
    panic(err)
}

for _, files := range list {
    fmt.Println(files.Name())                                          //確認讀入檔名
    encrypted_file, err := ioutil.ReadFile(path + "/" + files.Name()) //用.Name()去抓出資料夾內的檔案的名稱並讀取
    if err != nil {
        fmt.Println("read dir error")
        return
    }
    fmt.Printf("%T\n", encrypted_file) //確認讀入內容
```

ioutil.ReadDir 讀取資料夾、ioutil.ReadFile 讀取單一檔案，這裡使用 ioutil.ReadDir 並搭配.Name()函數，叫出所有檔案之檔名，並以檔案名稱呼叫資料。

c. 將解壓縮後檔案解密

- 方法一：讀取私鑰檔案之後，再使用 rsa.DecryptPKCS1v15()函數去將檔案解密

```
func ParseRsaPrivateKeyFromPemStr(privPEM string) (*rsa.PrivateKey, error) {
    block, _ := pem.Decode([]byte(privPEM))
    if block == nil {
        fmt.Println("Func ParseRsaPrivateKeyFromPemStr Decode")
        return nil, errors.New("failed to parse PEM block containing the key")
    }

    priv, err := x509.ParsePKCS1PrivateKey(block.Bytes)
    if err != nil {
        fmt.Println("Func ParseRsaPrivateKeyFromPemStr x509.ParsePKCS1PrivateKey")
        return nil, err
    }

    return priv, nil
}
```

使用 ParseRsaPrivateKeyFromPemStr()函數可將我們預存在電腦中的私鑰的 pem 檔讀取，並由[]byte 轉換成為 rsa.PrivateKey 的資料型態，如此才可以利用 rsa.DecryptPKCS1v15()函數去解密資料。

參考資料：
https://stackoverflow.com/questions/13555085/save-and-load-crypto-rsa-privatekey-to-and-from-the-disk

- 方法二：在讀取私鑰檔案之後，直接使用 rsa.DecryptPKCS1v15()函數去將檔案解密，並將整個流程寫成函數。

```
func RsaDecrypt(ciphertext []byte) ([]byte, error) {
    block, _ := pem.Decode([]byte(privateKey))
    if block == nil {
        fmt.Println("Func RsaDecrypt Decode")
        return nil, errors.New("private key error!")
    }
    priv, err := x509.ParsePKCS1PrivateKey(block.Bytes)
    fmt.Println(priv)
    if err != nil {
        fmt.Println("Func RsaDecrypt x509.ParsePKCS1PrivateKey")
        return nil, err

    }
    return rsa.DecryptPKCS1v15(rand.Reader, priv, ciphertext)

}
```

參考資料：
http://blog.studygolang.com/2013/01/go%E5%8A%A0%E5%AF%86%E8%A7%A3%E5%AF%86%E4%B9%8Brsa/

d. 儲存解密後之檔案

```
fw, _ := os.Create(depath + "/" + "de" + files.Name()) //開檔案位置
n, err := fw.Write(TESTa)                              //將內容寫入檔案
if err != nil {
    fmt.Println("fw.Write error")
    fmt.Println(err)
}
defer fw.Close()
fmt.Println(n)
```

使用 os.Create()、fw.Write()將資料寫入指定位置的檔案。

Table 3 decrypt.go 函數輸出輸入格式整理

函數名稱	輸入格式	輸出格式/動作
ParseRsaPrivateKeyFromPemStr	string （讀取後的.pem檔）	*rsa. PrivateKey
rsa.DecryptPKCS1v15	*rsa. PrivateKey	將檔案解密

三、程式碼

1. management.go

```
// managment
package main

import (
	"os"
	"fmt"
	"io/ioutil" // file io

	"crypto/rand"
	"crypto/rsa"
	"crypto/x509"
	"encoding/pem"
)

func Check(err error) {
	if err != nil {
		panic(err)
	}
}

func CreateKey(who , folder string, size int) {
	newPrivkey, err := rsa.GenerateKey(rand.Reader, size)
	Check(err)

	// create pem file
	PemRrikey := []byte(RsaPriToPem(newPrivkey))

		newPubkey := &newPrivkey.PublicKey
	PemPubkey := []byte(RsaPubToPem(newPubkey))

	// https : //golang.org/pkg/io/ioutil/#WriteFile
	err = ioutil.WriteFile("../"+folder+"/key/"+who+"pri_key.pem", PemRrikey, 0644)

	if err != nil {
		fmt.Printf("Error creating Key file!")
		os.Exit(0)
	} else {
		err = ioutil.WriteFile("../PublicKeys/"+who+"pub_key.pem", PemPubkey, 0644)
	}
}
```

```
func RsaPriToPem (rsaPrivkey *rsa.PrivateKey) string {
	// *rsa.PrivateKey to []byte：x509.MarshalPKCS1PrivateKey
	// https://stackoverflow.com/questions/13555085/save-and-load-crypto-rsa-privatekey-to-and-from-the-disk
	privkey_bytes := x509.MarshalPKCS1PrivateKey(rsaPrivkey)

	privkey_pem := pem.EncodeToMemory(
		&pem.Block{
			Type:  "RSA PRIVATE KEY",
			Bytes: privkey_bytes,
		},
	)
	return string(privkey_pem)
}

func RsaPubToPem (rsaPubkey *rsa.PublicKey) string {
	// *rsa.PublicKey to []byte：x509.MarshalPKIXPublicKey
	pubkey_bytes, err := x509.MarshalPKIXPublicKey(rsaPubkey)
	Check(err)

	pubkey_pem := pem.EncodeToMemory(
		&pem.Block{
			Type:  "RSA PUBLIC KEY",
			Bytes: pubkey_bytes,
		},
	)

	return string(pubkey_pem)
}

func main() {
	// Creat keys
	//  角色、資料夾名稱、key 長度(byte)
	CreateKey("sender", "Encrypt", 4096)
	CreateKey("receiver", "Decrypt", 4096)

	fmt.Println("Done!")
	}
```

2. encrypt.go

```
// file
package main

import (
	"os"
	"fmt"
	"io/ioutil" // file io
	"errors"
	"archive/zip"
	// example:https://www.itread01.com/content/1546726868.html

	"crypto/rand"
	"crypto/rsa"
	// "crypto/sha256"
	"crypto/x509"
	"encoding/pem"
)

var (
	ReceiverPubkey *rsa.PublicKey
)

func Check(err error) {
	if err != nil {
		panic(err)
	}
}

func PemToRsaPub (pubPEM string) (*rsa.PublicKey, error) {
	block, _ := pem.Decode([]byte(pubPEM))
	if block == nil {
			return nil, errors.New("failed to parse PEM block containing the key")
	}

	pub, err := x509.ParsePKIXPublicKey(block.Bytes)
	if err != nil {
			return nil, err
	}

	fmt.Println("pub=",pub)

	switch pub := pub.(type) {
	case *rsa.PublicKey:
			return pub, nil
	default:
			break // fall through
	}

	return nil, errors.New("Key type is not RSA")
```

```
}

// Read Files
func ReadFiles(folder string) ([][]byte, []string) {

	dir := folder+"/"
	files, err := ioutil.ReadDir(dir)
	fmt.Println(files,"\nlen=",len(files))

	Check(err)

	FileData := [][]byte{}
	FileName := []string{}
	for _, file := range files {
		filecontent, err := ioutil.ReadFile(dir + file.Name())
		Check(err)

		FileData = append(FileData, filecontent)
		FileName = append(FileName, "Crypt_"+ file.Name())
	}

	return FileData, FileName
}

// Encrypt Files and Compress
func encryptfile(folder string) {

	// Read files
	FileData, FileName := ReadFiles(folder)

	// encrypt and zip files
	fzip, _ := os.Create(folder+"(encrypt).zip")
	w := zip.NewWriter(fzip)
	defer w.Close()
	for i, filedata := range FileData {
		fw, _ := w.Create(FileName[i])

		// encrypt file
		// hash_data := sha256.Sum256(filedata)
		// https://ithelp.ithome.com.tw/articles/10188698
		encryptedmsg, err := rsa.EncryptPKCS1v15(rand.Reader, ReceiverPubkey,
filedata[:])
		Check(err)

		_, err = fw.Write(encryptedmsg)
		Check(err)
		// fmt.Println(n)
	}
}
```

```
func main() {

	fmt.Println("[]byte vs []unit8")
	// uint8    the set of all unsigned    8-bit integers (0 to 255)
	// byte      alias for uint8
	a := []byte{1, 1}
	b := []uint8{2, 2}

	B := func(b []byte) []byte {
		return b
	}(b)

	fmt.Printf("\ntype of a:%T\ntype of b:%T\ntype of B:%T\n", a, b, B)

	// Read Receiver Public Key file
	receiver_pubPEM, err := ioutil.ReadFile("../PublicKeys/receiverpub_key.pem")
	Check(err)

	ReceiverPubkey, err = PemToRsaPub(string(receiver_pubPEM))
	Check(err)

	// encrypt file in "Files" folder
	encryptfile("Files")
	fmt.Println("Done!")

	}
```

3. decrypt.go

```
// file
package main

//參考 https://www.wandouip.com/t5i259203/
//參考
http://blog.studygolang.com/2013/01/go%E5%8A%A0%E5%AF%86%E8%A7%A3%E5%AF%86%E4%B9%8Brsa/
//各種形式加密解密 https://blog.csdn.net/u013565368/article/details/53081195
//函數形式參考 https://github.com/Vaultpls/Go-File-Encryption-AES/blob/master/enc.go
import (
	// "encoding/pem"
	"errors"
	"fmt"
	"io/ioutil" // file io
	"os"

	// "log"
	"archive/zip"
	// example:https://www.itread01.com/content/1546726868.html

	// "crypto"
	"crypto/rand"
	"crypto/rsa"

	// "crypto/sha256"

	"crypto/x509"

	"encoding/pem"
	"io"
	// "path/filepath"
)

var (
	privateKey, _ = ioutil.ReadFile("./key/receiverpri_key.pem")
	publicKey, _  = ioutil.ReadFile("./key/receiverpub_key.pem")
)

func main() {

	fmt.Println(privateKey)
	fmt.Printf("privateKey orginal TYPE : %T\n", privateKey)

	priv, err := ParseRsaPrivateKeyFromPemStr(string(privateKey))

	fmt.Println(priv)
	fmt.Printf("privateKey converted TYPE : %T\n", priv)
```

```
    encryptedFile := "./Files(encrypt).zip" //加密後檔案之壓縮檔
    path := "./DeCompressZip"                    //解壓縮檔儲存位址
    depath := "./dcrypted"                       //解密檔儲存位址

    DeCompressZip(encryptedFile, path) //解壓縮

    os.Mkdir(depath, 0777) //一定要打這個才會創建新路徑

    list, err := ioutil.ReadDir(path) //ioutil.ReadDir 讀資料夾、ioutil.ReadFile 讀單一檔案 ；
用 list 叫出資料夾的基本性質
    if err != nil
{                           //https://blog.csdn.net/yxys01/article/details/78136295
        fmt.Println("Read DeCompressZip")
        panic(err)
    }

    for _, files := range list {
        fmt.Println(files.Name())                                          //確認讀
入檔名
        encrypted_file, err := ioutil.ReadFile(path + "/" + files.Name()) //用.Name()去抓出
資料夾內的檔案的名稱並讀取
        if err != nil {
            fmt.Println("read dir error")
            return
        }
        fmt.Printf("%T\n", encrypted_file) //確認讀入內容

        TESTa, err := rsa.DecryptPKCS1v15(rand.Reader, priv, encrypted_file) //解密  //方
法一
        // TESTa, err := RsaDecrypt(encrypted_file)
    //方法二
        // fmt.Println("TESTa = ", TESTa) //確認 TESTa 內容

        if err != nil {
            fmt.Println("rsa.DecryptPKCS1v15 error")
            panic(err)
        }

        fw, _ := os.Create(depath + "/" + "de" + files.Name()) //開檔案位置
        n, err := fw.Write(TESTa)                                    //將內容寫入檔案
        if err != nil {
            fmt.Println("fw.Write error")
            fmt.Println(err)
        }
        defer fw.Close()
        fmt.Println(n)

    }
```

```
}

//解壓縮 https://blog.csdn.net/wangshubo1989/article/details/71743374
//解壓縮 https://studygolang.com/articles/7471

func DeCompressZip(File, dir string) {

	os.Mkdir(dir, 0777) //建立一個目錄（資料夾）

	cf, err := zip.OpenReader(File) //讀取 zip 檔案
	if err != nil {
		fmt.Println("Func DeCompressZip rader")
		fmt.Println(err)
	}
	defer cf.Close()
	for _, file := range cf.File {
		rc, err := file.Open() //開檔
		if err != nil {
			fmt.Println("Func DeCompressZip open")
			fmt.Println(err)
		}

		f, err := os.Create(dir + "/" + file.Name) //開檔案位置
		if err != nil {
			fmt.Println("Func DeCompressZip os.Create")
			fmt.Println(err)
		}
		defer f.Close()                  //關檔
		n, err := io.Copy(f, rc) //覆寫
		if err != nil {
			fmt.Println("Func DeCompressZip io.Copy")
			fmt.Println(err)
		}
		fmt.Println(n)
	}

}

func ParseRsaPrivateKeyFromPemStr(privPEM string) (*rsa.PrivateKey, error) {
	block, _ := pem.Decode([]byte(privPEM))
	if block == nil {
		fmt.Println("Func ParseRsaPrivateKeyFromPemStr Decode")
		return nil, errors.New("failed to parse PEM block containing the key")
	}

	priv, err := x509.ParsePKCS1PrivateKey(block.Bytes)
	if err != nil {
		fmt.Println("Func ParseRsaPrivateKeyFromPemStr x509.ParsePKCS1PrivateKey")
		return nil, err
	}
```

```
	return priv, nil
}

func RsaDecrypt(ciphertext []byte) ([]byte, error) {
	block, _ := pem.Decode([]byte(privateKey))
	if block == nil {
		fmt.Println("Func RsaDecrypt Decode")
		return nil, errors.New("private key error!")
	}
	priv, err := x509.ParsePKCS1PrivateKey(block.Bytes)
	fmt.Println(priv)
	if err != nil {
		fmt.Println("Func RsaDecrypt x509.ParsePKCS1PrivateKey")
		return nil, err

	}
	return rsa.DecryptPKCS1v15(rand.Reader, priv, ciphertext)

	}
```